VOL. 33, NO. 12 DECEMBER, 1956

AMERICAN JOURNAL OF OPTOMETRY *and* ARCHIVES *of* AMERICAN ACADEMY OF OPTOMETRY

EDITOR
CAREL C. KOCH

EDITORIAL COUNCIL
MEREDITH W. MORGAN, JR. Chairman
ROBERT E. BANNON
IRVIN M. BORISH
PAUL L. CONNOLLY
RUDOLPH EHRENBERG
V. J. ELLERBROCK
ISIDORE FINKELSTEIN
HAROLD M. FISHER
GLENN A. FRY
MONROE J. HIRSCH
HENRY W. HOFSTETTER
J. DONALD KRATZ
BERNARD MAZOW
O. L. MCCULLOCH
HERMAN SAGER
MAX SCHAPERO
KENNETH B. STODDARD

CONTENTS

ORIGINAL PAPERS

Differential Diagnosis in Optometric Practice.
David D. Michaels 625

An Approach to the Problem of a Corrected Curve Achromatic Cataract Lens.
J. K. Davis and Gilbert Clotar 643

EDITORIALS

Comments on Reduced Enrollments.
Carel C. Koch 661

Merry Christmas.
Editors and Staff 663

SPECIAL REPORTS

John Benson — 2nd Lord Charnwood, 1901-1955.
by Sir Arthur Bryant 663

An Evaluation of the Mechanical Aspects of Hearing-Aid Spectacles.
Monroe J. Hirsch 668

ERRATA

The Helmholtz Checkerboard Pattern.
Glenn A. Fry 673

TRANSACTIONS OF THE ACADEMY

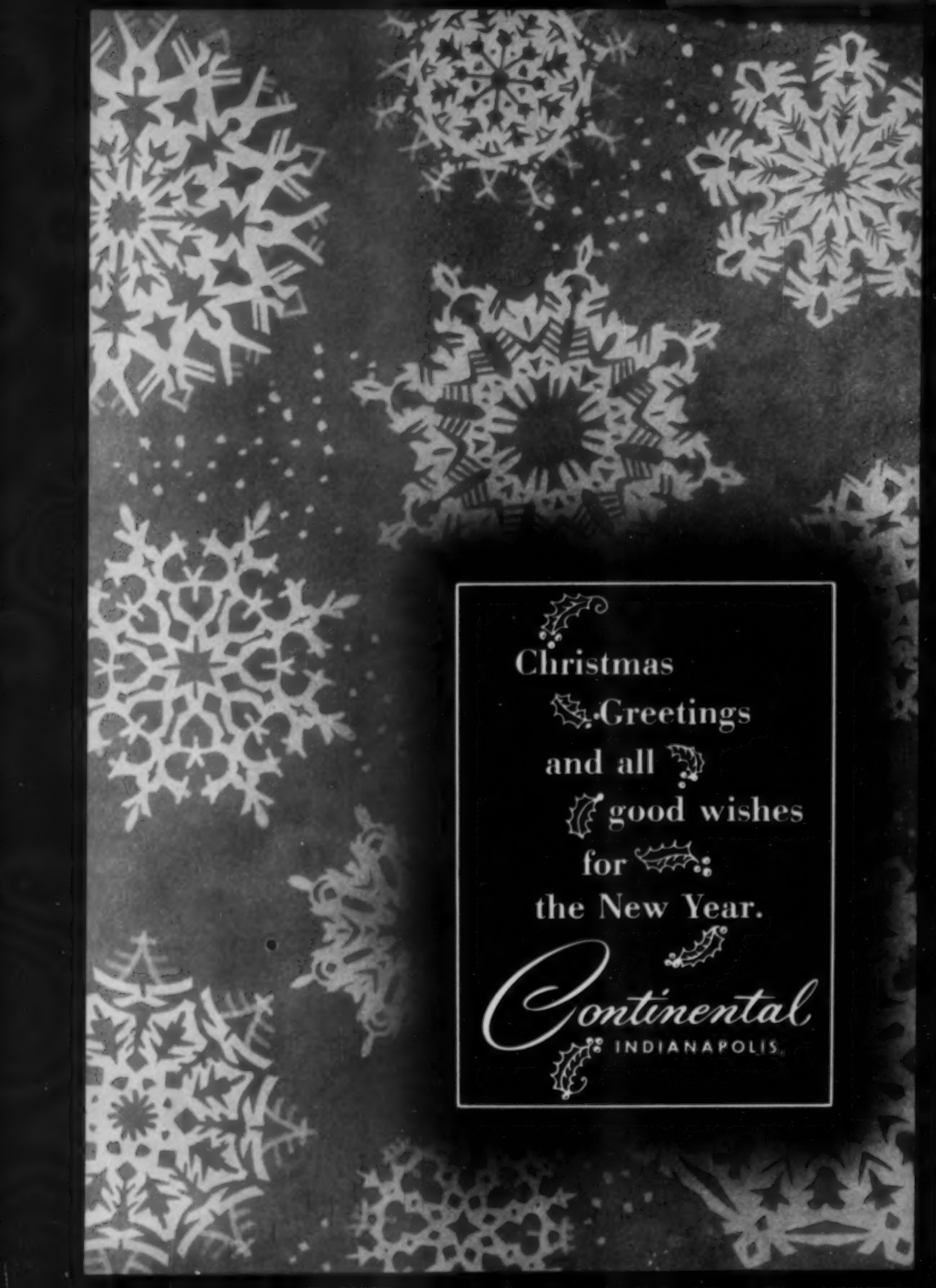
Annual Report of Secretary-Treasurer.
Carel C. Koch 675

GENERAL INDEX, 1956. Volume 33 675-682

Published Monthly by the AMERICAN JOURNAL OF OPTOMETRY PUBLISHING ASSOCIATION, 1508 Foshay Tower, 821 Marquette Ave., Minneapolis 2, Minn.

ANNUAL SUBSCRIPTION, UNITED STATES and CANADA $7.00. FOREIGN $7.50.
Single Copies, 70c

Entered as second-class matter, February 20, 1924, at the post office at Minneapolis 2, Minnesota, under the Act of March 3, 1879
Established 1924


Christmas
Greetings
and all
good wishes
for
the New Year.
Continental
INDIANAPOLIS

Season's Greeting's!

The Holidays—
the best time of the year—time of
good cheer—renewed
friendships—gift giving.
The time when one pauses
to reflect on the best things
in life—health, prosperity,
peace and happiness.

May All of These Be Granted
You in the Coming Year!

MANUFACTURER
ART-CRAFT OPTICAL CO., INC.
ROCHESTER, NEW YORK

wishing you a

MER

If you haven't received your 1957 B&L Calendar, ask for a copy on your letterhead: Dept. F-064, Bausch & Lomb Optical Co., Rochester 2, N. Y.

RY
XMAS
and New Year Prosperity!
BAUSCH & LOMB
Ray-Ban
Ray-Ban
Ray-Ban
Bal-Air

Merry Christmas and a Good 1957

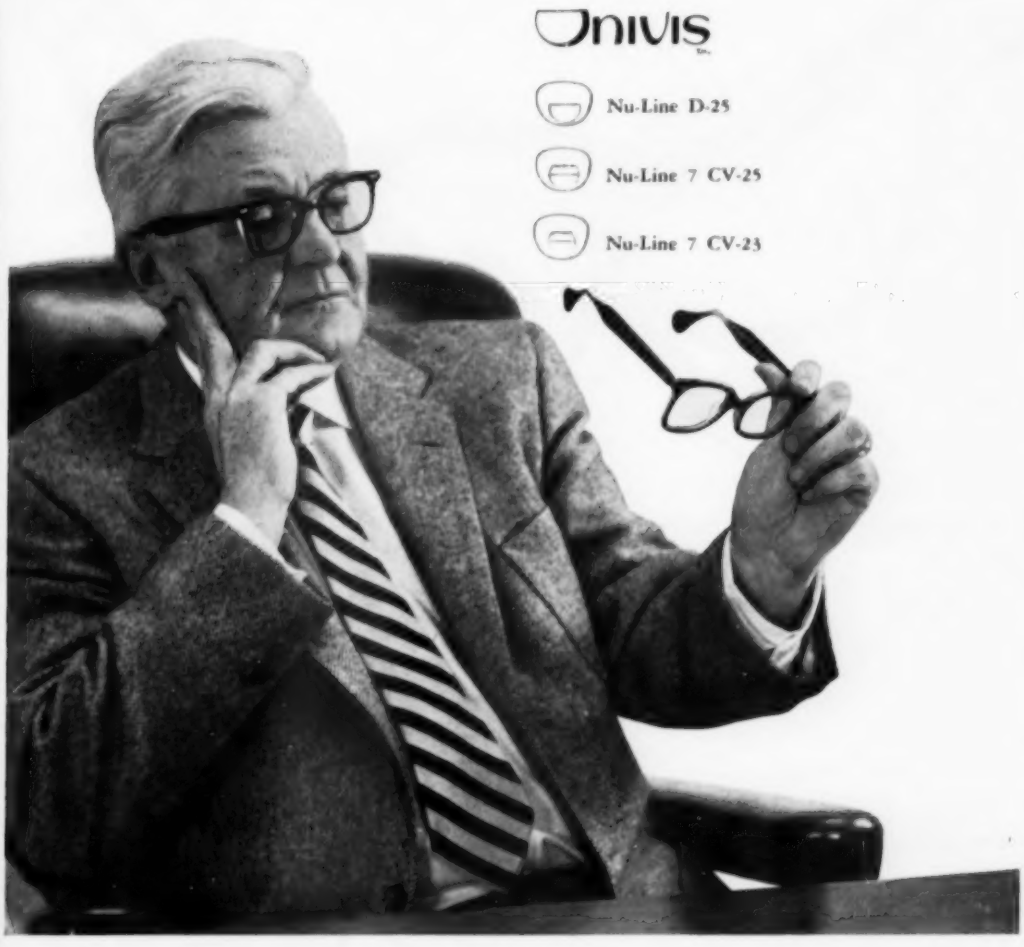
SHURON OPTICAL COMPANY, INC.

SHURON

Geneva, N.Y.
Rochester, N.Y.

It's amazing how
Univis Nu-Line treatment of multi-
focal segments tends to increase patient
pleasure. It aids refractionist and dispenser
satisfaction, too; makes time more profitable.
Prescribe Univis Nu-Line 7 CVs, now in 23 mm.
and 25 mm. wide segments. Also, the new wide
segment bifocals, with *special* Nu-Line treat-
ment, are now in stock: the Univis Nu-Line
D-25 series. Call your Univis laboratory for
these new lenses—all bases, adds and tints,
and all in the Univis corrected curve
series; thin segments.

UNIVIS NU-LINE stands between you and patient problems



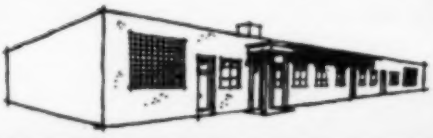
Each year one frame stands out--

THIS YEAR THE *FRAME*

BELLE CAROLINE™

Notice the crispness of line and definition of shape. Observe the delicate upsweep achieved by *illusion* and color treatment rather than extreme outline. Note how distinctive color silhouette minimizes bulk at the bridge and draws attention upward and outward for the season's most flattering contour.

Products of the Frame Division



IS BY UNIVIS Univis !

Jewel-brow

Also with Colorsmic brow complimenting frame color

BELLE CAROLINE SOCIETE' T.M.

Basic colors were selected for wardrobe versatility and conformity to season's fashion shades. Temples compliment fronts, even to the *color silhouette*, in Belle Caroline. Societé, with Coloramic or Jewel-brow, further projects Caroline styling with added touches for dressy occasions.

SIZES: Eye—42, 44, 46; bridge—18, 20, 22;
TEMPLE: 4", 4¼", 4½" (LB).

THE UNIVIS LENS COMPANY / DAYTON, OHIO

Season's Greetings

AND
OUR BEST WISHES FOR

A
PROSPEROUS

NEW YEAR
FROM

American Optical
COMPANY

Staffed to serve you better

when you send your Rx to Benson's hundreds of **optical craftsmen** assure you of quality service

On your next Rx, try BENSON'S *— dedicated to provide unexcelled Rx service to the ophthalmic professions since 1913*

Yes, one of the resources at your disposal at BENSON'S is the experience and skill of our optical craftsmen.

And, coupled with this know-how is what we call *"Quality-Desire."*

These outstanding technicians have the desire to excel – to do each operation just a little better than normally required. This extra attention to details on *every* Rx spells *Quality* for you.

This quality service is yours with no slow-down in delivery. BENSON'S is staffed and equipped to handle its volume of prescription service with optimum efficiency – and doing the job right the first time eliminates costly and time-consuming re-works.

Benson
OPTICAL COMPANY

Executive Offices • Minneapolis 2, Minn.

COMPLETE LABORATORIES CONVENIENTLY LOCATED IN UPPER MIDWEST CITIES

AMERICAN JOURNAL OF OPTOMETRY
and ARCHIVES *of*
AMERICAN ACADEMY OF OPTOMETRY

Vol. 33 December, 1956 No. 12

DIFFERENTIAL DIAGNOSIS IN OPTOMETRIC PRACTICE*

David D. Michaels†
Illinois College of Optometry
Chicago, Illinois

INTRODUCTION

The term "diagnosis" is derived from the Greek and means knowing apart. The concept of differentiation is therefore implicit and no further qualification would be necessary were it not for common usage. The term "differential diagnosis" has come to be reserved for that activity by which one distinguishes among various abnormalities which give a similar clinical picture.

When a patient presents himself to us for consultation, the first question we both want answered is whether some visual abnormality is present. The next problem is to decide what kind of abnormality it is. Finally, depending upon the decision we have made, we will select suitable steps and procedures to relieve, alleviate, or eliminate the cause of the patient's complaints. Such therapeutic procedures may be supplied by the optometrist, or the patient may need to be referred to other members of the team of health professions for consultation and/or treatment.

From the practitioner's viewpoint, the process of diagnosis involves two inter-related activities. First, he must gather together the necessary data (history, observation, examination). Second, he must evaluate these data in terms of the particular patient's problem. The inter-relation of these two activities is to be emphasized. From the history, and especially the chief complaint, and from his background knowledge of the normal and its variations, certain impressions will have been formed which will serve to guide what data are to be looked for and what can be safely omitted. It is foolish to deceive one's self that any abnormality will become apparent if only we gather enough information or perform enough tests. The man who doesn't know when to take visual fields would not know how to interpret the information if he had it.

*Read, in part, before the annual meeting of the American Academy of Optometry, Chicago, Illinois, December 10, 1955. For publication in the December, 1956, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.
†Optometrist, M.Sc., Member of faculty, Fellow, American Academy of Optometry.

As a general rule, once having made a diagnosis, we commit ourselves to a definite plan of action, i.e., we give or withhold treatment, specify what the treatment will be and estimate its effectiveness, duration, cost, etc. As Carl Shepard would put it, we stake our professional reputation on this decision, to which we might add, that the patient's vision and perhaps his total welfare is similarly in the balance.

Here, it is possible only to highlight some of the procedures and problems involved. The following "ingredients" and their diagnostic implications are discussed more fully elsewhere.

THE HISTORY

Good history taking is an art which can be considerably improved by practice and experience. To note only that the patient has headache or blurred vision or that his eyes tire is diagnostically valueless. The significance of the history stands in direct ratio to the information we have about the onset of the complaint, its duration, recurrence, location, radiation, severity, factors likely to precipitate, aggravate or relieve it, its relation to other findings and whether it is improving or getting worse. Such an elaboration is of special importance when there is little or no objective evidence to serve as a basis for the complaint.

The history often provides us with valuable clues as to etiologic, predisposing or contributing factors of visual anomalies. An ocular or systemic disease of the past may have left some visual malfunction as a sequel; on the other hand, the visual disturbance may be the earliest manifestation of an existing morbid process. The extent, both qualitative and quantitative, to which the patient uses his eyes, the work distance, illumination, detail and required precision are essential elements to be considered in the diagnosis and treatment.

A good history is a complete history. It is useful, therefore, to review with the patient some of the major signs and symptoms which the patient or clinician may have omitted or overlooked. A brief statement concerning each, *whether positive or negative*, helps to remind the practitioner a year or two later that he did not forget or fail to notice such complaints.

DIAGNOSTIC VALUE OF THE HISTORY

It would seem almost self-evident that the purpose, the rationale, for eliciting a history is to arrive at a diagnosis. Yet how often one finds that in the final disposition of the case, it has remained a thing apart, unrelated to the findings of the examination, diagnosis, prognosis or treatment. In a popular booklet dealing with "basic procedures of the analytical examination" there is not a single reference to the history either as to procedure or as it applies to the evaluation ("typing") of

the patient's condition! In fact, the only time *symptoms* are mentioned at all, the author refers, not to the patient's complaints, but to the test results.

Unfortunately, there are no "tests" by which one can establish the presence of pain, discomfort, headache, anxiety, itching, burning and other subjective complaints. Only the patient can tell what he feels or sees or indeed if he can see at all. Systems of "case analysis" which arrive at diagnostic conclusions independent of the patient's symptoms are incomplete and fallacious. A wise diagnostician once said, let me take the history and I will take the word of any good interne on the physical findings. How applicable these words are to those who would turn diagnosis into the mechanical routine of flipping, knob-twirling, chaining and rearranging of test results.

It is no doubt true that there are times when the history is of little diagnostic value. The symptoms may be vague and non-specific or the patient's statements unreliable, illiterate or incoherent. More often than not, however, the history is invaluable, surprisingly dependable and sometimes absolutely essential to the diagnosis. Thus, the impressions of retrobulbar neuritis, chronic simple glaucoma, toxic amblyopia and hysterical blindness depends primarily on the history. In a great many other disorders, the history first arouses our suspicion and directs the subsequent plan of investigation on the basis of which a diagnosis can be made.

The apparently superficial and casual approach of the expert clinician differs from the stilted questionnaire style of the beginner primarily because the former lets the patient guide him while the latter depends on pre-printed questions which may have little or no bearing to the case at hand. As a result, he learns something about the patient *as a person* while the beginner merely fills out some previously empty lines on a record sheet.

When people are ill or when they cannot function adequately in their physical or emotional environment, they seek help. The help must be geared to their need—the physical need of one, the emotional need of another. Such aspects will not be brought out by retinoscopy or duction tests but they are present as undertones, in the patient's choice of words and manner of speaking, as casual remarks or answers to pointed questions, in his attitude towards his symptoms, examiner and treatment. This is perhaps the major reason why each practitioner must take his own history and why it can never be delegated to an associate or assistant.

THERAPEUTIC VALUE OF THE HISTORY

The history is not only a story which one must listen to because it has diagnostic value. It is an important therapeutic tool. Many, perhaps all, patients require and deserve an explanation of their symptoms in terms of their understanding and daily routine. Reassurance and moral support, tactful encouragement and, at the very least, a sympathetic ear. There is an art to listening just as there is an art to asking questions. All this is a form of psychotherapy if you like: I prefer to call it a humane approach to human beings.

THE INTERPRETATION OF SYMPTOMS

Contrary to what textbooks may lead one to believe, clinical diagnosis begins with signs and symptoms and not with names or labels of disorders. The analysis of symptoms in terms of the various likely mechanisms which may be responsible for them is an extremely useful and practical exercise. One might ask himself the question: "Given this symptom, what disorder *should* the patient have?"

Symptoms (and signs, too) are the outward manifestations of some underlying disturbance which we must attempt to discover. It is useful, although somewhat artificial, to think of symptoms as the manifestations of abnormal function and signs as the consequence of altered structure. Often, there is a time interval between these functional and structural changes which provides a valuable clue for diagnosis and prognosis. The progress of glaucoma from early functional to later structural fundus changes is a case in point. One of the reasons why undergraduates have considerable difficulty in relating what they find to the "classical" descriptions given in textbooks is failure to appreciate this time element. Textbooks tend to emphasize the later, more severe and perhaps more dramatic aspects of a disorder. Sometimes they fail to indicate that certain findings may appear at one stage and disappear at another. This should be contrasted with the emphasis upon early manifestations by the diagnostician. It is these early features which present a problem and whose detection is so often essential for adequate treatment and management.

Symptoms rarely exist in isolation, hence it follows that a constellation of symptoms (or syndrome) has greater diagnostic value. Headache by itself means little but headache coupled with visual field changes is something else again. There are, incidentally, so many possible contributing causes to headache that one is seldom justified to assign an ocular cause to it without corroborating evidence. Even on therapeutic trial, the disappearance of this symptom following the wearing of corrective spectacles is not conclusive for many times a neu-

rotic element is involved. Such symptoms may be especially baffling as they continue to persist after all "apparent" reason for them has been eliminated.

It is helpful to think of visual disorders as *processes* rather than entities in order to remind ourselves that we are dealing with an active, continuously changing phenomenon. Unfortunately, any single clinical examination can only reveal one frame, as it were, in the moving picture of the disorder. By serial examination and especially by the history we can *reconstruct* for ourselves a "three-dimensional" picture of the patient's problem.

THE RELATION OF SIGNS AND SYMPTOMS

There will be times when the history reveals no symptoms although the examination indicates the presence of some disorder. More often, there will be complaints without corroborating physical findings. Usually there will be some of each and an effort must be made to discover their cause and their inter-relation:

1. *If there are no symptoms, but manifest physical evidence:* consider the possibility that (a) the structural changes have as yet spared function; or (b) functional *compensation* has taken place which masks overt evidence of damages or (c) the patient is physically insensitive to the defect.

2. *If there are symptoms but no corroborating physical evidence:* consider the possibility that (a) the process has not progressed far enough or (b) lasted long enough to produce structural damage. Functional changes quite often precede organic ones in time and severity hence this group constitutes a wonderful opportunity for early recognition. Also to be considered is the possibility that (c) the symptoms have no inherent organic basis (the so-called functional disorders). Note that I have placed this consideration last (not because it is unimportant, but because so often it must be established by the exclusion of the others).

3. *If there are both signs and symptoms:* one must consider whether (a) they are consistent with each other suggesting a common basis or (b) they are inconsistent suggesting the possibility of more than one disorder and (c) if they are qualitatively (as well as quantitatively) related thus giving evidence of exaggeration or minification in terms of the patient's response to his disorder.

PRESYMPTOMATIC DIAGNOSIS

Something should also be said about those patients who manifest neither signs or symptoms. An increasing proportion of private as well as public eye clinic patients seek professional consultation not because

they have any particular difficulties but as a routine measure. This represents a considerable gain in health education for there are no natural motivations to seek preventive care. The task of getting people to present themselves for early diagnosis and treatment is part of the professional responsibility of every practitioner. It indicates concern with optimum human efficiency as well as the problem of impairment resulting from disease. And this, after all, is the essence of *preventive optometry*. Preventive optometry has its application in (1) promoting optimum visual efficiency; (2) early diagnosis and treatment (with referral if necessary); (3) limiting disability and blindness, and (4) rehabilitation.

THE PSYCHOLOGY OF SYMPTOMS

That organic disorders often have concommitant psychological manifestations (I hesitate to call them complications) has been known since antiquity. Indeed, our viewpoint is literally and figuratively quite different when we are on our feet or flat on our back. It is therefore not surprising to find that visual disorders may impose great handicaps in social, professional or recreational spheres of activity. This may require considerable concessions, regressions, repressions and other forms of psychological adaptive reactions. Conversely, such reactions may initiate or precipitate organic disorders. Few symptoms will not have such psychological overtones and emotional undercurrents.

What does the symptom mean to the patient? Is it a burden to be borne stoically and heroically, or a punishment for past digressions or getting old; does it serve a purpose in satisfying some emotional need? Such considerations enter into a proper evaluation of symptoms and in planning a satisfactory program for their elimination. Many a "bifocal problem case" might have been solved if the practitioner had remembered that there is more to it than segment size, inset and "jump."

The lack of corroborating physical findings does not make a symptom of "psychological" origin. This is a corollary of a principle so important that it should be shouted from the roof-tops, namely: *To state that a given phenomenon is psychological is to define a problem, not offer a solution for it.* A diagnosis of psychogenic etiology commits one to the task of uncovering the basic emotional or personalistic conflict. This may be relatively simple or, more often is time consuming and requires expert professional help.

While such symptoms may follow a definitive pattern in their onset, character, duration, frequency, etc., they must be evaluated in terms of the facts that: (1) the dividing line between normal and abnormal behavior is an arbitrary one; (2) "abnormal" behavior

may be perfectly normal under certain circumstances; (3) abnormal behavior can never be diagnosed on the basis of any single observation or testing procedure, but depends upon an aggregate of findings in their appropriate contextual setting and, to repeat again, (4) psychogenic symptoms may be superimposed upon organic complaints to which they may or may not be related.

The differentiation between psychogenic symptoms and "malingering" has been overemphasized in the past. Not only is malingering relatively rare (especially in private practice) but there is a growing awareness that the malingerer may well be a psychologically disturbed person.

THE ART OF LOOKING

Disease, wrote Professor Clendening, leaves its mark upon the look in a man's eye, the mottling of his skin, the swing of his leg, the bend of his back, the heave of his chest. The expert clinician, like the experienced public speaker, *looks at his audience*. The trained senses can perceive much at a glance, but it is useless to look unless one knows what to look for. Practice and experience, here as everywhere else, helps to sharpen the eye and educate the senses; after all, even Sherlock Holmes was not born an acute observer.*

The type of observation I have in mind does not consist in staring endlessly at the patient as if he were a microbe under a magnifying glass. Rather, it is a systematic plan of looking and deducing from what is seen and begins the moment the patient enters the office. This ability or art of looking is highly developed among taxicab drivers, porters and headwaiters, but the deductions with which we are concerned at the moment are of scientific rather than financial interest.

How much we can tell about a patient and the disease he has or to which he might be predisposed depends not only on how carefully we observe, but upon available statistical knowledge of incidence and prevalence. Thus, the 55-year-old executive is not only a candidate for presbyopia, but for cataract, diabetes, hypertension, degenerative cardio-vascular disease and cancer. We know at first glance that the fundus of such a patient deserves extra consideration, that a growing mole on the side of his cheek or a history of shortness of breath are strong indications for medical consultation. The amount of information to be gathered by careful inspection is practically unlimited and we have time only for some examples to illustrate the point.

*It is both interesting and pertinent that Sir Arthur Conan Doyle was a physician and that the inspiration for his phenomenal detective was one of his teachers in *clinical* medicine.

The body is covered by skin. It is the first line of defense against infection, it blushes in modesty, pales in fright and contracts in horror. The laymen speaks of a healthy looking skin and the advertisers of the "skin you love to touch," recognizing intuitively that a host of disorders have cutaneous reflections and manifestations. The pale skin of anemia, the yellow color of jaundice, the stretched shiny areas of edema, the scars of past injuries, eruptions of allergy and swellings of inflammation, all serve as signs that something is amiss.

The patient's gait as he walks across the room, his movements and posture, speech and hearing may be a veritable mine of neurologic information. Is there a cough or hoarseness, has he trouble catching his breath, is he sweating, even the nicotine stained fingers of the heavy smoker may be worth noting.

Some of us are inclined to consider the face only as a supporting framework for the spectacles we prescribe. On the other hand, the difference between the face in health and in disease is often dramatic and always informative—indeed the characteristic face of the moribund patient was first described by Hippocrates about 400 B.C. There is the frightened appearance of Grave's disease, the apathetic expression of myxedema, the relaxed smooth features of paralysis, the distorted skull of acromegaly, the wrinkled, inelastic face of the old man. All have been the subjects of poet and painter and help to guide the clinician as to the disposition of the case.

The optometrist, as well as the dentist, is frequently afforded the opportunity of observing manifestations of systemic disease before the patient seeks medical aid or of which he may be totally unaware. He may or may not find corroborating ophthalmoscopic or perimetric evidence, but the old adage that an ounce of prevention is worth a pound of cure is nowhere more true than here. Referring such patients for prompt medical attention should afford the optometric practitioner a real sense of pride and professional achievement. He has discharged his obligations not only to the eyes but to the total patient.

THE OCULAR EXAMINATION

There are those who perfunctorily pull down the lower lid, glance briefly at the eye, perform ophthalmoscopy while maintaining a delicately discrete distance of one-half foot and wisely proclaim that the eye is normal. I have never been able to master these shortcuts and it is doubtful that they yield much diagnostic information. The essential ingredients of an adequate ocular examination are (1) follow a definite plan so that nothing of importance will be overlooked; (2) have a "mental picture" of what constitutes a normal eye. Unfortunately the

"normal" is never a sharp line or even an average, but a *range* of multiple physiologic variations. How many of us, for example, could list off-hand 20 or more physiologic ocular changes which occur with senility?

DIAGNOSTIC VALUE OF THE OCULAR EXAMINATION

One should remember that most people have two eyes. While this may sound trite, I have frequently observed clinicians go about the examination of each eye as if they belonged to separate individuals. Let us rather take advantage of this biologic fact, especially since, in most cases, one eye is perfectly normal, by *comparing one eye to the other*. It is surprising how many suspected anomalies will be found to be perfectly duplicated in the opposite eye (a good although by no means conclusive clue that one is dealing with a physiologic variation).

The teaching of this subject to undergraduates for some years has led me to the conclusion that the principles of good clinical examination are best grasped if they are built upon a sound foundation of ocular anatomy and physiologic optics. For example, a knowledge of the structural relations of the orbit leads naturally to a consideration of the paranasal sinuses in diseases of this area; appreciation of the course and attachments of the orbital septum helps in differentiating extra and intra-orbital affections; the functions and innervation of the extra-ocular muscles in health provides a basis for the analysis of spasms, paresis and paralysis; papilledema becomes intelligible in terms of the continuity of optic nerve and cerebral coverings and perimetric interpretation is impossible without a working knowledge of the course and distribution of nerve fibers in the visual pathway.

It would be impossible here to enter into a discussion of the mechanics of procedure and interpretation of the ocular examination. There are, however, certain basic pathologic principles which are worth keeping in mind as the examination proceeds. Having decided that a given finding is not compatible with physiologic variation consider whether it is:

1. *Congenital:* While these disturbances are not too common, coloboma is by no means rare. The history is of prime importance. Not all congenital disturbances are hereditary: Premature birth (retrolental fibroplasia) and rubella during the first trimester of pregnancy as well as gonorrhea may lead to blindness in the newborn.

2. *Inflammatory:* Here this is indicated by the cardinal signs of redness, increased local temperature, pain, photophobia, lacrimation and loss of function. Local deviations from this pattern occur in the eye due to avascularity and insensitivity of some structures. While repair is a normal consequence of injury, it often results in the formation of opaque

scar tissue and serious interference with vision. Early recognition and prompt referral are therefore essential.

3. *Circulatory Change:* These may result from disorders of the heart or follow peripheral vascular disturbances. The fundoscopic indications are congestion, increased tortuosity, altered permeability (with the formation of transudates and exudates), thrombotic and embolic phenomena with resultant hemorrhages, ischemia, pallor and loss of functions. The ophthalmoscope allows an unrivalled view of living retinal vessels but attention should also be given to the conjunctival, circumcorneal, ciliary and choroidal vessels.

4. *Retrograde Change:* These are the cellular and tissue manifestations of disturbed metabolism (failure of supply, transport utilization or elimination of essential metabolites). The atrophic changes following optic nerve injury, the fatty degeneration of arcus senilis and xanthelasma, the hyaline thickening of sclerosed vessels, the pinguecula of the conjunctiva and probably cataractous opacification fall into this category.

5. *Disturbance of Growth:* Although growth is a physiologic process accomplished by enlargement and multiplication of cells, under certain circumstances, it occurs for no apparent reason, to no apparent purpose and without following physiologic rules and regulations. Depending upon its location, and whether benign or malignant, a tumor produces injury by pressure, invasion, interference with normal blood supply and secondary inflammatory changes. Clinical findings may include diplopia, paresis, anomalous vision, perimetric findings, photopsia, a palpatory or visible swelling and contributing findings from the history. For obvious reasons, any such disturbance suggests immediate ophthalmologic consultation.

PRACTICAL CLINICAL TESTS OF VISUAL FUNCTION

What tests should be included *as a minimum* in the examination of visual functions is a question frequently asked by student and practitioner alike. In analyzing this question, one should consider: (1) the prevalence of visual disorders; (2) the consequences of a *delay* in diagnosis and treatment; (3) practicability in terms of available time and equipment.

Although there is some difference of opinion among various authorities on this matter, these are more frequently along the line of adding to, rather than subtracting from, the list which is a fairly natural consequence of the evolution of better diagnostic methods. Nevertheless, one eventually reaches a point of diminishing returns, especially when one finds that, as the list of tests grows longer, there is a tendency to omit some of the more basic ones in favor of those which are currently

considered more elegant and impressive. It would seem more appropriate to reserve such tests to situations where definite indications suggest their special application.

The following are believed to be useful clinical tests because: (1) *they require little time* and no special or expensive instrumentation, hence are applicable to the majority of patients even in emergency situations or for screening purposes; (2) *they are of proved value* in that they yield the most information for the time spent; (3) they indicate what *direction*, if any, further investigation should take. (Routine methods applied in the external and internal ocular examinations are not included.)

1. *Visual Acuity.* This is perhaps the single most valuable test of visual function since most disorders, in one way or another, are related to it. In this respect, the Snellen chart still provides the best index of all-around seeing ability (as compared to the more scientific resolution targets). A reduced Snellen chart is available for near point testing. If the acuity is reduced with or without the old correction lenses, a pinhole will often reveal the source of the difficulty. The multiple pinhole disc is to be preferred since it is easier for the patient and requires less time.

2. *Near Point of Convergence.* The finger or a pencil provides a rapid, fairly accurate indication of the convergence amplitude and hence the status of this function. The eyes should be observed for objective diplopia and the direction they move after the "break." The test is applicable to squinters as well as non-squinters. The pupillary response during the test should be inspected. An amplitude of between ten and twelve meter angles is compatible with good binocular function, although there is some decrease with age.

3. *Near Point of Accommodation.* A reduced Snellen or other type of letter chart is used monocularly and binocularly. The amplitude is compared to the chronologic age. Alternate clearing and blurring may suggest spasticity. (The minus lens to blur test, incidentally, does not measure amplitude of accommodation.) A decreased amplitude is observed in most severe illnesses, hence is not pathognomonic of presbyopia. Inequality in ciliary response should be investigated.

4. *Versions, Rotation and Fixation.* The finger or other simple target is moved in the eight cardinal directions to determine the extent, smoothness and coordination of the ocular globes. Fixations are conveniently taken by presenting both fists, about one meter apart in the various directions and alternately opening and closing the hand (or a finger). Sluggish or incoordinated movements must be investigated for

lesions in the efferent (motor) pathway or some congenital or acquired sensory obstacle to the visual act. Concomitant strabismus should be differentiated from paralytic strabismus by the character and variability of the angle of deviation.

5. *Confrontation Fields.* A long pin with a white ball head serves as a useful target in comparing the patient's peripheral field of vision to that of the examiner. Gross incongruities only are demonstrable by this test and serve as an indication for more detailed perimetric studies. Central fields should be taken on all patients whose acuity is not improved by the pinhole disc.

6. *Color Vision.* This function is quickly and conveniently tested by the isochromatic plates. The skein-matching test is less sensitive but more practical for youngsters. A controlled source of illumination should be available. Although color deficiency is generally on a hereditary basis, this test also provides a diagnostic clue as to the functioning of the cones since anything which reduces their numbers or efficiency may affect the color vision.

7. *Cover Test for Latent Deviations.* This test provides a rapid objective method of estimating the degree and direction of both lateral and vertical phorias. An evaluation of the phoria thus revealed in terms of the convergence and accommodative tests will often yield a clue as to the nature of any binocular imbalance. The test is also of value in differentiating heterophoria from heterotropia.

8. *Window Image Test for Corneal Curvature.* This test will reveal evidence of distortion, scarring or other irregularities in corneal curvature. It is sometimes possible to estimate the nature and degree of astigmatism and whether the cornea is of a myopic or hypermetropic type. More accurate results require the use of the ophthalmometer.

9. *Test for Sensory Fusion.* A simple and fairly reliable index of sensory fusion (Worth) is obtained by means of stereoscopic cards including the bird in the cage: four balls and stereoscopic acuity for the three degrees of fusion. When a stereoscope is not available, I prefer the so-called "fusion recovery test." A red glass is placed before the right eye, and the patient observes a muscle light. A strong disassociating prism is placed before the left eye and the response noted. The prism is then removed and the time required to regain single vision is recorded.

10. *Test for Refractive Error.* Static retinoscopy is the quickest available objective method for detecting the quality and quantity of refractive error. While the prescription of spectacles should not be based on this method alone, it is not only a convenient short-cut to the subjec-

tive test for ametropia, but is of diagnostic value when the two results differ by more than half of one diopter.

SOME COMMON DIAGNOSTIC PROBLEMS

In the limited space at my disposal, I should like to comment briefly on some of the more common diagnostic problems which one meets in every-day practice. The selection of topics is based on statistical data of incidence. Details of treatment and prognosis are omitted.

There is a considerable body of evidence which confirms the clinical impression that patients of different age groups present disorders more or less peculiar to them. This implies that methods of examination and diagnosis must be adopted and designed to meet the needs of each group. The following table lists some of the more outstanding visual problems at various ages:

SOME VISUAL PROBLEMS AT VARIOUS AGE PERIODS

Prenatal	Genetic factors: albinism, retinitis pigmentosa, etc. Infection via mother: congenital syphilis, rubella, etc. Prematurity: oxygen induced retrolental fibroplasia. Malformations: buphthalmos, microphthalmos, etc.
Neonatal	Crede's prophylaxis against gonorrhea. Drug reactions. Birth injuries. General problems of incomplete structural and functional development: accommodation, convergence, tear production, nerve fiber myelination, incomplete pigmentation.
Infancy	Hypermetropia due to disequilibrium between development of length and refractive power. Development of visual recognition, color vision, ocular coordination. Physiologic nystagmus. Progressive emmetropization. Special methods of examination necessary.
Preschool Child	Period of rapid learning. Hypermetropia tends to disappear. Recognition and visual discrimination play important role in mental and social integration. Accidents are leading cause of blindness during this period.
School Child	Visual readiness for school. Screening and annual visual examinations. Myopia may develop rapidly. Strabismus and amblyopia should be investigated. May obtain cooperation of child for orthoptics during this period.
Adolescence & Maturity	Special problems in adolescent's reaction to visual correction, treatment and examination. Increased visual load imposed by higher education. Myopia eventually stabilizes. Cosmetic appearance often more important to patient than functional adequacy. Glaucoma, trauma, toxemia, infection are problems of maturity.
Senility	Presbyopia main problem. Cataract, senile ocular degenerative changes (arcus senilis, xanthelasma, pterygia, etc.). Decreased elasicity of iris, lids; macular changes; retinal vessel changes consequent to cardiovascular disease, diabetes, etc.
Death	Ocular changes following death. Problems of preserving, storing and transporting of tissue for ocular transplants.

1. *Refractive Error.* Not only is there disagreement about the etiology of ametropia, but there is considerable confusion regarding its definition. For the most part, this is due to an attempt to classify refractive error in terms of variables which are, as yet, not clinically measur-

able. Thus "axial myopia" means little unless one is prepared to present X-ray or eikonometric evidence of elongation; "curvature ametropia" can neither be ruled in or out by the ophthalmometric findings; "index ametropia" is thought to account for secondary refractive changes seen in diabetes, drug intoxication and pre-cataractous states. An even more indefensible position is one which defines ametropia in terms of the response to lenses (e.g., myopia is that condition requiring concave lenses to obtain standard acuity). Not only does this tell us very little (even emmetropic vision is often improved by concave lenses) but it may be misleading in cases of spasticity ("pseudomyopia"). Those who speak of "physiologic" and "pathologic" ametropia have not come up with convincing evidence of any "growth imbalance" (cancer is a growth imbalance but few would consider it physiologic) or any specific pathologic changes related to ametropia. Classifications based on rates of progression are generally based on hindsight rather than clinical predictability.

The etiology of ametropia is, in most instances, unknown but the diagnosis of "essential" or idiopathic ametropia should not be made until all known causes (e.g., ciliary spasticity, binocular imbalance, certain ocular and systemic disease, drugs and poisons, structural changes consequent to congenital defect or physical injury and degenerative changes of ocular tissues) have been excluded. While most of these mechanisms are rare at least a certain number of them are subject to specific therapy.

The clinical diagnosis of refractive error represents a compromise between knowledge and empiricism. Neither refractive power nor axial length is usually measured but rather the *outcome* of a number of dioptic variables. We use visual acuity as an indicator of the optimum lens power and assume that the two are equivalent. When they are not, as when the acuity is reduced for any number of functional or organic reasons, considerable difficulty may arise in the differential diagnosis. The lack of correlation between the degree of ametropia and subjective complaints imposes additional diagnostic and therapeutic problems.

2. *Binocular Imbalance.* A state of binocular imbalance is said to exist when, in the absence of any overt deviation of the eyes, there is a disequilibrium between the requirements for single vision and the sensory-motor adjustments which mediate it such as to lead to the production of symptoms or reduced efficiency. It may exist independently, concurrently or as a result of refractive error. In rare instances it may contribute to the etiology of the ametropia. No generally reliable data are available as to the incidence of these disorders but they are probably quite common. Although a refractive disorder is often

associated, it is difficult to evaluate whether the symptoms are the result of the imbalance or the ametropia. Correction of the ametropia usually corrects the associated imbalance. This suggests that the emmetropic correction may be worth a therapeutic trial before positive treatment of the imbalance is attempted.

The differential diagnosis of binocular imbalances is a complex and difficult task depending to a great degree upon the theoretical assumptions of etiology of the individual clinician. Consideration should be given to (1) accommodation, (2) convergence, (3) innervational factors, (4) mechanical disturbance and (5) psychogenic factors in the pathophysiology. The age of onset, rate of development, subjective symptoms and response to treatment are helpful diagnostic points. It is worth re-emphasizing that quite often the imbalance is a monster of our own creation (inadequate decentration, positioning of lenses and anisometropic correction).

3. *Strabismus.* Strabismus (heterotropia) can be considered an uncompensated deviation of the ocular globes. Every optometric practioner should be thoroughly acquainted with the differential diagnosis of paralytic and concomitant strabismus for the prognosis and therapeutic approach are quite different in each. The differentiation may be difficult in cases of paresis, amblyopia or inability to demonstrate a fusion reflex. The following points may prove helpful:

PARALYTIC STRABISMUS	CONCOMITANT STRABISMUS
1. Often definite history of onset	1. Rarely definite history of onset
2. Onset usually after 5th year	2. Onset usually before 5th year
3. Head tilting common	3. Head tilting rare
4. Angle of deviation varies with eye position	4. Angle of deviation tends to remain constant
5. Diplopia common	5. Diplopia rare

In paralytic strabismus (and perhaps in concomitant squint as well) the ocular deviation is a symptom rather than a cause. The underlying condition may be neurologic, toxic, infectious, mechanical, degenerative, traumatic or due to a congenital malformation. The proper identification of the responsible mechanism will guide the therapeutic approach and determine the prognosis. Thus, mechanical pressure by a benign tumor may allow for specific surgical cure.

In the early stages, the strabismus may be spastic due to neural irritation rather than paretic.

Concomitant strabismus must be differentiated from the intermittent manifestations of a high phoria (so-called latent strabismus):

from physiologic incoordination of the eyes in infants; and from pseudo-deviations consequent to a large angle Kappa or Gamma).

Techniques for the testing and identification of various types of strabismus are numerous and well discussed in the literature. The differentiation between alternating, monocular, esotropia and exotropia, etc., as well as the age and intelligence of the patient, degree of acuity, duration and magnitude of the squint are important in the selection of treatment. The practitioner should be familiar not only with the indications for orthoptics but also with those which suggest other forms of treatment (including surgery).

4. *Amblyopia.* There is a deplorable tendency to diagnose as "amblyopia" any reduction in acuity not improved by lenses or the pinhole disc (a small pinhole may in fact reduce acuity by creating diffusion rings). It is my practice in our clinic never to approve a diagnosis of amblyopia unless the foveal reflex has been seen and the macular area shown to be free of gross pathology.

As one reviews the various definitions of amblyopia in the literature it will soon become apparent that this is a "residual" entity—a diagnosis by exclusion. The importance of the differential diagnosis is therefore obvious.

Most definitions are concerned more with what amblyopia is not, rather than positive identifying features (although association with strabismus, hypertropia and anisometropia are suggestive). This is a logical but unfortunate consequence of our ignorance concerning its pathogenesis. As our knowledge increases, it is to be hoped that the number of cases falling into this residual category will decrease.

Amblyopia may be separated from suppression by the simple expedient of occluding the good eye. In suppression the acuity improves immediately. Toxic causes, especially tobacco and alcohol generally produce bilateral involvement and should be ruled out by the history and central field studies. Other causes of optic neuritis must be considered, especially the retrobulbar variety which has been described as a condition in which neither the doctor nor the patient can see anything. The progressive nature of these conditions and eventual involvement of the rods are helpful diagnostic points.

There is considerable *physiologic* variation in visual acuity from one individual to another and in the same individual at different ages. These must not be confused with amblyopia.

A certain proportion of (some claim all) amblyopes appear to suffer their loss of acuity from inadequate fixation—so-called subclinical strabismus. The methods of Lazich, Broch and Givner and

others allow detection of this anomaly which responds very well to orthoptic treatment (up to 85% with proper selection). Whether such patients should still be classified as amblyopes (since the loss of acuity is more or less consistent with the decreasing cone population as one proceeds extra-foveally) is a moot question.

The apparatus developed by Goldschmidt (which depends upon the Haidinger brushes phenomenon) provides a simple, apparently effective method of testing the integrity of the macula. Its prognostic value may help settle the vexing question of whether the amblyopia is congenital or acquired. Of various other methods (including the Hall test), only the response to treatment is a reliable though not very helpful diagnostic criterion.

The possibility of psychosomatic mechanisms should be considered, although they are probably quite rare. The diagnostic significance of a central scotoma is not clear nor is the incidence of this finding in amblyopes. It is generally agreed, however, that it carries a poor prognostic value.

For some strange reason, there are usually few, if any, subjective symptoms associated with amblyopia.

5. *Asthenopia.* Asthenopia (literally, weakness of the eye) is a word used by professional people while the layman speaks of "eyestrain," although I have never been able to determine exactly what either group means by this term. Conventionally it is used to describe any one or combination of symptoms (including headache, discomfort, irritability, "fatigue," itching, etc.) resulting from the use of the eyes. It is therefore a convenient diagnosis for lazy clinicians since it relieves them of the task of investigating individual (specific) symptoms. Further, it implies a causal relationship between these and the use of the eyes which has never been satisfactorily demonstrated.

While the extra-ocular muscles, nerves and retina have been excluded as possible sites of strain, the "use-reserve" concept continues to dominate our thinking with respect to binocular balance in general and ciliary muscle action in particular. The clinical observation that small errors of refraction are more likely to produce symptoms than large ones and that in myopia and presbyopia symptoms are usually not present, has been attributed to an attempt on the part of the patient to compensate for small errors and a lack of effort to overcome insuperable ones—a sort of physiologic defeatism. One wonders why a young patient with good amplitude ever obtains relief with a +0.50 D. lens since the reserve is much more than adequate.

The pathologic consequences of such effort remains a complete

mystery. Outside a simplified laboratory situation we are left with no organic basis for fatigue. The concept that fatigue is subjective and eyestrain related to "conflict and frustration" is an intriguing one. I have often felt that behind the complaint "my eyes tire" is a person who is really tired of his work, his wife, his role in life or his social situation. Such factors are difficult to evaluate, hence the importance of an adequate history. On the other hand, such an approach leaves unexplained why severe hypermetropes, myopes, presbyopes and amblyopes (all highly conflict-arousing conditions) so seldom complain of eyestrain.

SUMMARY AND CONCLUSIONS

Diagnostic reasoning is an art which can be considerably improved by a carefully taken, properly evaluated history; an appreciation of the patient as a person; a thorough ocular examination and the judicious and selective use of clinical tests for measuring various aspects of visual function. A number of common clinical entities have been reviewed with these considerations in mind. It should be emphasized that in the construction of a differential diagnosis those conditions, even though they may be uncommon, which are subject to specific treatment should be given first priority. After having listed (or thought of) all the likely mechanisms which might be responsible for the patient's signs and symptoms, one may begin to whittle these down by selecting those tests and procedures which provide the most specific answers. In this manner optometric tests become not part of a mechanical routine, but tools in a case study.

AN APPROACH TO THE PROBLEM OF A CORRECTED CURVE ACHROMATIC CATARACT LENS*

J. K. Davis† and Gilbert Clotar‡
Research Department, American Optical Company
Southbridge, Massachusetts

The problem of designing a corrected curve and/or achromatic cataract lens seems to have been passed by, as design of ophthalmic lenses has progressed in the past few years. True, there have been advances in making the lenses more cosmetically attractive and lighter in weight. However, the optical performance of the newer lenses is not greatly improved from the older types of lenses. There is a significant difference in the performance between a plano convex lens and a 3.00 base, but beyond that, no great progress has been made.

It is obvious that there is room for improvement, and if improved cataract lenses could be made available to the people who need them, an important group of our population would receive better vision than they have been receiving heretofore.

It is common knowledge that cataract lenses suffer severely from marginal astigmatism, marginal power errors, chromatic aberration, and distortion. This plurality of defects, itself, although creating ample room to work in, poses a problem. Which one is the most annoying? How can one balance the residual aberrations of the various types to obtain optimum results from the standpoint of the patient? If it is not feasible to correct all aberrations, which should be emphasized? How far will the patient go in doing away with weight and cosmetic appearance factors in order to obtain optical performance? In designing many types of lenses, the types of compromises which can be made are much more accessible for evaluation than is the case with designing a new cataract lens.

Early study of the design problem revealed that there were three basic approaches which could be undertaken. One would be to correct astigmatism and power errors by means of aspheric surfaces. The other would be to correct chromatic aberration by means of using two different indices of glasses in a cemented or fused doublet, and the third would

*Read before the annual meeting of the American Academy of Optometry, Chicago, Illinois, December 11, 1955. For publication in the December, 1956, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†A.B., Fellow American Academy of Optometry, Research in Ophthalmic Lens Design, Head Optical Computing and Service Section, Research Department, American Optical Company.

‡M.S., Research in Lens Design, Programing Engineer, Optical Computing and Service Section, Research Department, American Optical Company.

be to try to combine the two, to correct astigmatism and to correct color in a single doublet type of lens.

In a spectacle lens any doublet type is automatically lenticular in one form or another. Because of this, there is always a temptation to reduce the spot size to save weight and thickness. In order to determine what size spot might be used in such lenses, it was necessary to undertake a brief study of the effect of lenticular spots on the field of view and the relative weight and thicknesses involved for different lenses with different spot sizes.

When we speak of balancing defects to obtain optimum performance in any design task, whether we realize it or not, we are weighing various characteristics of the object to arrive at a single index of quality in order to say that one design is better than another.

In order to weigh the merits and evaluate the various designs which we expected to consider, it was necessary to develop a single figure of merit, some one criterion by which different lenses which were correcting different aberrations could be compared.

It was necessary to consider the possibility of a lens series based on at least one of the various designs.

It was necessary to make a photographic evaluation of these concepts of design and of figure of merit, in order to demonstrate the compromises which were being made and the improvements which were being achieved.

We had been aware that aspheric cataract lenses were not new, but until we began to work on the problem, we had not realized the extent to which all three of these approaches had been studied before. Several approaches had been made in Germany between 1900 and 1915 resulting in corrected curve doublets and anastigmatic aspheric cataract lenses.[1, 2, 3] Dr. E. D. Tillyer patented an achromatic lens which did not correct astigmatism but which did correct color, and was made in a lenticular form with an invisible spot.

In order to present the entire problem as we have been studying it, this paper will discuss:

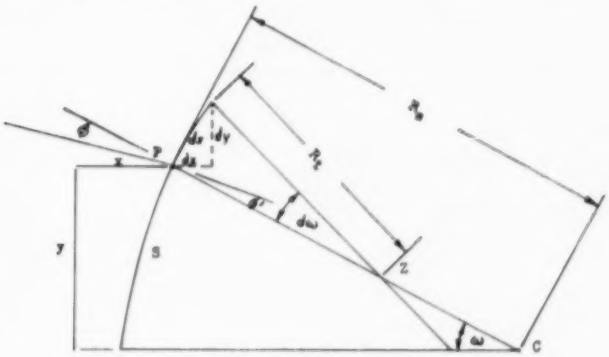
1. The method of approach in designs of aspheric cataract lens.
2. The principle of a corrected curve doublet.
3. A consideration of the earlier work on the problem—or modification of the achromatic doublet.
4. A study of field of view and spot size. Weight and thickness of various lenses.
5. The development of a figure of merit.

6. An outline of the possibilities of a lens series.
7. Photographic evaluation of various styles of lenses.

ASPHERIC LENS

This project was set up to study the improvements in cataract lenses which might be obtained by the use of aspheric surfaces, particularly aspheric interfaces in a crown-flint type doublet. In the process of studying these possibilities, it was found that considerable improvement in color, astigmatism and power for oblique fields of view could be obtained with spherical surfaces alone. This improvement was at the expense of some additional thickness, some additional weight, and some additional complexity in manufacture over conventional cataract lenses.

The question now comes up: What advantage would aspheric surfaces have? Except for very strong lenses above +15.00 D, very little, if color correction is desired. The lateral color correction is a result of the negative refraction at the interface and therefore requires a steep interface which means a lens of about the same appearance and shape as the spherical type.



$$d\omega/dy = \frac{d\,(\mathrm{Tan}^{-1}\, dx/dy)}{dy}$$

$$= \frac{d^2x/dy^2}{1 + (dx/dy)^2}$$

$$ds = \frac{dy}{\cos\omega} = R_t\, d\omega$$

$$d\omega/dy = 1/R_t \cos$$

$$R_t = \frac{1 + \mathrm{Tan}^2\omega}{\frac{d^2 x}{dy^2}\cos\omega}$$

Fig. 1.

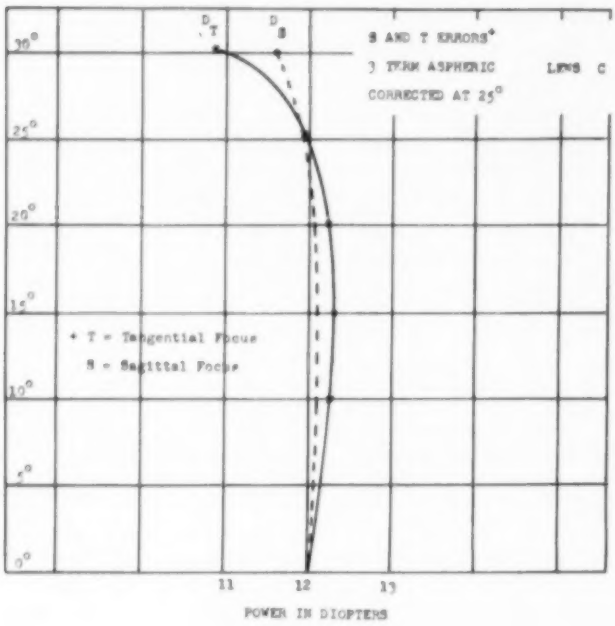


Fig. 2.

Another type of aspheric cataract lens was also considered. This type would be similar to the present style E lenticular except that the front surface would be aspheric. This would make possible a "blending" of the border line and result in a lightweight lens corrected for power, and astigmatism, better looking than the present style E, but not corrected for color. This is a serious drawback. The design of such a lens is shown as lens C, Figure 3.

The design of aspheric spectacles corrected for marginal power and astigmatism is not difficult. Equations have been developed which are straight forward to use. The method is indicated below.

A METHOD OF DESIGNING AN ASPHERIC SPECTACLE LENS CORRECTED FOR MARGINAL POWER AND ASTIGMATIC ERRORS

By using techniques similar to those by which the astigmatism of a surface is computed, one can compute the curvature in each meridian which would yield zero astigmatism or cancel out the astigmatic error present in a bundle of rays as they strike a particular point on the surface.

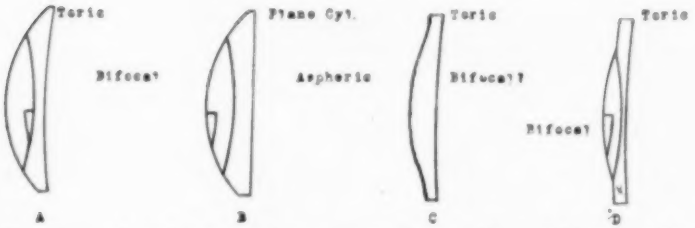


Fig. 3. Types of possible corrected curve cataract lenses. (A) —3.00 D. base doublet spherical surfaces, achromatic. (B) Flat doublet spherical surfaces, achromatic. (C) —3.00 D. base single lens aspheric. (D) —3.00 D. base lenticular doublet, spherical, achromatic.

By tracing rays through the lens to the aspheric surface so that they strike this surface at various heights, the curvature required for zero astigmatism at each of these heights can be determined. Solution of a system of simultaneous equations gives the equation of a surface which yields this freedom from astigmatism. Although there are limits to which this method may be put, it is sufficiently accurate to permit its use in cataract lens correction. To all intents and purposes such a lens may be considered well corrected.

The next step is to find a means of *expressing* a surface which has the required radius in each meridian at designated points. If we express X in terms of Y, the surface can be expressed as

$$X = ay^2 + by^4 + cy^6 \ldots\ldots\ldots\ldots\ldots\ldots$$

In the diagram (Figure 1)* since S, the surface, is a figure of revolution PC is R_s, the radius of curvature at P in the meridian perpendicular to the paper. PZ is the radius of curvature in the plane of the paper (R_t).

It is obvious that $dx/dy = \tan\omega$, $y/R_s = \sin\omega$, dx/dy is the first derivative of the equation above.

In using these formulas, it is necessarly to correct *from* the spherical radius, to the aspheric, all other differential changes that are not important changes in ϕ, ϕ' and y. (ϕ and ϕ' are the angles the incident and refracted rays make with the normal to the surface.) In the example cited, a reasonably good correction was obtained through a 25° field

*The customary form of the expression for radius of curvature is given in terms of $\frac{dy}{dx}$ instead of $\frac{dx}{dy}$ and is exemplified as found in *Smithsonian Mathematical Formulae and Tables of Elliptic Functions* from Smithsonian Miscellaneous Collections, Vol. 74, No. 1, page 38, paragraph 2.222. We chose the alternate form because our x is the dependent variable instead of the independent as is assumed in the theoretical discussion of this type of curve.

(all that is useful in style E) by using only three terms a, b, c. *a* is obtained by the paraxial relationship:

$$X = \frac{Y^2}{2R}, \qquad a = \frac{1}{2R}$$

b and c are found by expressing the first and second derivatives using the radii desired in each meridian. For a higher degree of correction or for angles above 25° or for stronger lenses, additional points will be needed; the procedure for each point being the same. Each additional point considered adds two terms to the equation. The data for the lens under discussion follows:

Ocular radius (—3.00 1.53)	176.66 mm
Front radius (paraxial)	36.55 mm
Center thickness	4.6 mm

Equation of front surface: where the value

$$X = 1.3679 \times 10^{-2}y^2 + 3.8942 \times 10^{-6}y^4 - 3.7126 \times 10^{-9}y^6$$

Additional correction can be obtained by using more points and additional simultaneous equations requiring additional complexity which is undesirable in an illustrative example.

A plot of the residual aberrations in the above lens is shown in Figure 2.

PRINCIPLE OF A CORRECTED CURVE CATARACT LENS

When one analyzes why one cannot design a singlet cataract lens which is corrected for power and astigmatism for oblique fields of view, one can see the only door open for correcting these aberrations is a doublet lens. Looking at the upper diagram Figure 4, one can see that the very fact that the stop point is 27 mm back of the ocular surface, means that it is impossible to get a steep negative refraction, even though the ocular surface is negative. The rays that enter the eye suffer a positive refraction of the ocular surface because the radius of the ocular surface is longer than the stop point distance. They are bent toward the axis of the lens as if the surface was positive.

Now, if we consider astigmatism and power errors as a function of a refraction, a plus lens creating plus astigmatism and the negative lens creating minus astigmatism in the common sense of the word, one can see it is impossible to get any minus astigmatism from the rear surface of a cataract lens unless one makes the radius extremely steep. What is needed is a steep negative refraction somewhere to balance out the plus astigmatism which is present, largely at the ocular surface, and to a lesser extent at the front surface of the lens. This above is a physical

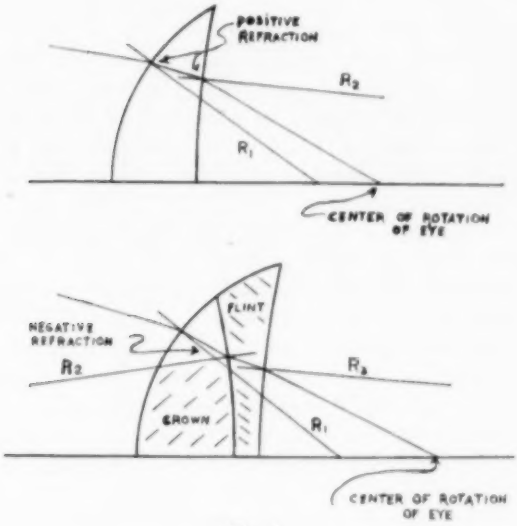


Fig. 4.

explanation for the Tscherning Elipse which shows that one cannot correct astigmatism above +7.00 diopters. In Figure 4 (lower diagram), we notice an interface where the front component is of lower index than the rear component. This interface provides us with the much needed negative refraction. It is the whole secret of a corrected curve doublet cataract lens. If we do not have a refraction of this type, we cannot get correction. Reversing the position of the glasses makes the lens worse than a singlet. It is obvious that the deepness of the curvature will affect the amount of correction. It is also at this same interface where we have a steep negative refraction that the lateral color is corrected, because no matter what the indices of the glasses are, we cannot correct lateral color unless we have a negative refraction—a negative bending of the field ray somewhere.

A CORRECTED CURVE DOUBLET

The corrected curve achromatic cataract lens which we will consider is similar to a simple telescope objective in composition. It is made of a crown positive front element and a flint negative rear element. Three forms are shown in Figure 3. Lens A, a slightly bent shape. Lens B, a plano convex form and Lens D, a slightly bent, bevel lenticular type. In all cases, the positive portion is crown (or barium crown) and the negative portion is flint.

With three surfaces to work with, there are a wide variety of forms possible—many of which have some merit. The negative flint element can be placed in front as was done in Germany, but this results in very steep curves and a limited field of view. The power and astigmatism varies with the over-all bending or concavity of the lens. It also is affected by the interface curve. It is obvious that with a given back curve and a given interface curve, the front curve is determined by the actual prescription considerations.

It was found that a lens with a flat back curve gave somewhat superior power correction with a proper interface curve at a point where there was minimum astigmatism, than did one with a deeper ocular curve. However, using a flat back placed a greater load on the interface curve so that the interface curve had to be steeper. This meant that the corrections would change more rapidly with field of view, and also meant that the lens would have to be made thicker and heavier than if a weaker interface curve and a slightly steeper back were used. A flat back lens also was inferior to a moderately curved back when used in toric prescriptions.

Figure 5 shows oblique curve errors for sagittal and tangential foci in diopters for four lenses showing how these errors vary with interface curve.

Table 1 lists aberrations, weights and thicknesses of some of these lenses which were considered early in the project.

EARLIER WORK IN THIS FIELD

Discussions of work in Germany on lenses such as we are considering are contained in the literature referred to in the references.

Lenses of three types were evidently designed by Von Rohr, Rodenstock and Gullstrand. All these lenses corrected lateral color very well and also astigmatism. The designers, apparently, were willing to let power error or field curvature go. Correcting these aberrations so completely, required strong curves and precluded successful wide fields of view, and toric surfaces in a practical lens series.

Another precedent is an achromatic cataract lens patented in 1937 by Dr. E. D. Tillyer of American Optical Co. (Figure 6). This lens was made of two 1.61 glasses, one barium, the other flint with a lenticular spot of barium fused into a major lens of flint. Because of the two glasses having the same index of refraction in the visible (sodium light), the lenticular spot was, to all intent and purposes, invisible.

A modification of this lens was also studied as a part of our program. It is referred to as the Achromat. The modification was to flatten

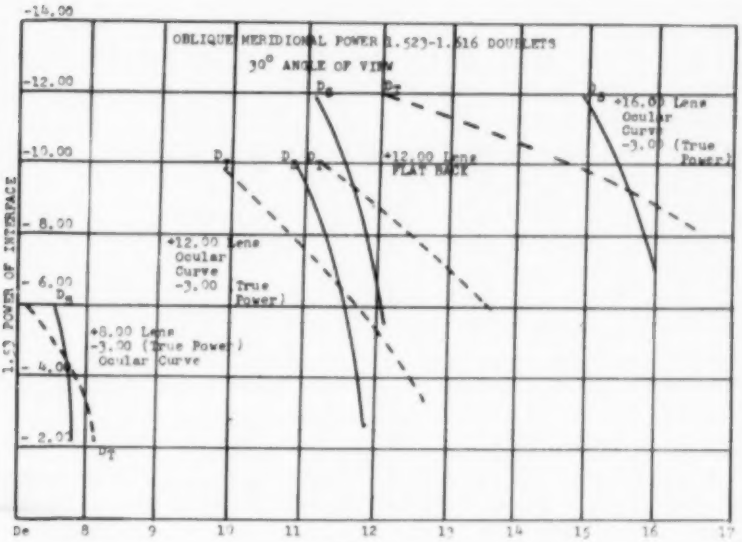


Fig. 5.

the interface curve to correct lateral color to a large extent, and let axial color go to some extent. This made possible larger fields of view without increasing thickness as much but it still requires more weight for large spot sizes than the corrected curve type.

FACTORS AFFECTING FIELD OF VIEW

This question of field of view deserves some expansion. It is difficult to locate reports of experiments which would clear up the uncertainty regarding it. A good many people who are in a position to know, or in a position to have observed eye movements, insist that the

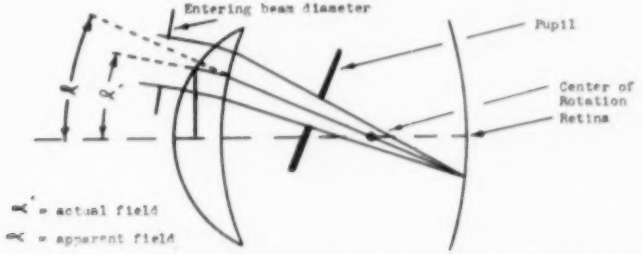


Fig. 6. Schematic representation of factors affecting the field of view through a lenticular lens.

TABLE 1

COMPARISON OF VARIOUS TYPES OF CATARACT LENSES

+ 12.00 D Sphere
Knife Edge Diameter 47 mm
Aberrations for the 30° Bundle

	Color	Power	Ast.	Approx. Wt. Grams	Thickness (mm)
Reg. —3 Base Lens	0.30	+0.90 D	+1.90 D	16.2	7.0
Doublet with 1616 Glass (—3.00 Base) (34 Spot)	0.11	—0.30 D	+0.15 D	21.5	7.5
Doublet with 1.70 Glass (34 mm)		—0.30 D	+0.20 D	24.7	7.0
Flat with 1.616 Glass (34 mm Spot)	0.10	—0.15 D	+0.15 D	24.8	7.5
Corrected Cemented Lenticular (30 mm Spot)	0.11	—0.30 D	+0.15 D	17.7	5.5
Style E Uncorrected (30 mm Spot)	0.30	+0.90 D	+1.90 D	11.1	4.6

average person does not move his eye more than ten degrees to the right and left. On the other hand, since we have become interested in this question, we have observed people in their conversation and reading, particularly people wearing glasses. We have found that a large number of people wearing moderate prescriptions move their eyes to the right and left so that they are actually intercepting their line of sight with the edge of the lens. The whole philosophy of a corrected curve lens series is based on the assumption that one should carefully consider errors at a field of view of 30° and that these errors are significant even in relatively weak prescriptions. Actually, whether one moves one's eyes or one's head is partly due to the many personality traits which one develops through the years. The personality of the person and the type of lens which he has been wearing, if any, of course affect these habits. One conclusion would seem fairly safe. There must be large numbers of people who would appreciate as large a field of view as can be given them and would be willing to pay extra for this field of view, and accept greater thickness in the lens, providing this extra weight and thickness did not become ridiculous.

THE EFFECT OF LENTICULAR SPOTS ON FIELD OF VIEW

Because of the magnification of cataract lenses, the actual field of view, that is the field of view which the patient sees in terms of what would seem by a person not wearing a cataract lens, is altered by the magnification of the cataract lens in two ways: first, it is diminished because the field of view in space in front of the patient is magnified so that as he turns his eye behind the lens, although he may turn his eye 30°, he is not scanning space through a 30° angle. In addition to this, the lens also tends to magnify the pupil size both by its power and by the fact that the edge of the lens is some distance from the pupil and the cone of light pointed at the retina projected back through the pupil to the lens is growing larger and larger. By the time this cone hits the front surface of the lens, it is considerably larger than the size of the pupil. For a comfortable, unflared, single image viewing, the pupil must not intercept the border line of the lenticular spot. The table in Figure 7 gives the actual field of view and the apparent field of view obtained with certain pupil sizes when the magnification factors of spacing and power of the lens are included. Table 2 is computed for a +12.00 diopter lens.

It will be noted that to obtain a field of view of 30°, it is necessary to approach a 40 mm spot size. This fact, combined with our photographic evaluation of lenticular lenses, led us to concentrate on large spot sizes in the further study of the problem.

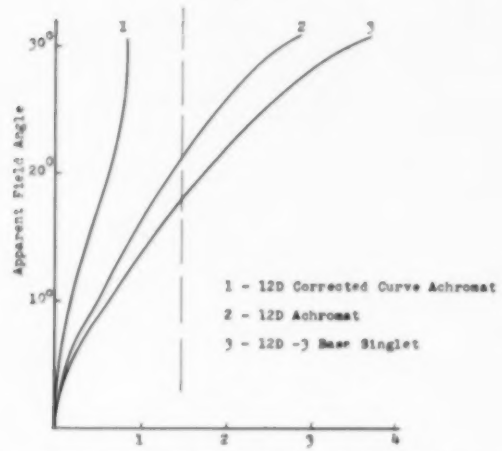


Fig. 7. Figure of Merit. Graph illustrating relative weighted correction of three types of cataract lenses. (Includes lateral color and marginal error.)

It is a little difficult to evaluate a patient's reaction to an increase in weight and thickness over what he has been accustomed to, or to his reaction to an increase in thickness rather than an increase in weight. In general, thickness and increase in thickness is simply an addition to a negative cosmetic appearance. Cataract lenses are far from attractive in the first place. Curvature of the lens and the thickness both tend to determine whether or not it has a bulky appearance. Choice of the frame also has a great deal to do with this. It is hoped that those who have an opportunity to help patients choose frames, use some discretion when they pick frames for cataract lenses. When it comes to evaluating an increase in weight, there is a little more to go on.

The sense of weight, like most senses, has a logarithmic rather

TABLE 2

SCHEMATIC REPRESENTATION OF FACTORS AFFECTING THE FIELD OF VIEW THROUGH A LENTICULAR LENS

Spot Diameter	Pupil Size	Magnified Pupil	App. Field	True Field
	3 mm.	4.2 mm.	23.27°	13.85°
30 mm.	4.5 mm.	6.3 mm.	20.9°	12.5°
	6 mm.	8.4 mm.	18.5°	11°
	3 mm.	4.2 mm.	31.37°	18.5°
40 mm.	4.5 mm.	6.3 mm.	29.9°	17.6°
	6 mm.	8.4 mm.	27.9°	16.5°

Table showing the variation on the field of view with pupil and spot size.

than a linear response, so that to have one weight feel twice as heavy as another, it would have to be several times as heavy. Since the interpretation of weight is logarithmic, a pair of spectacles weighing 25% more than another pair would probably be interpreted not as being 25% heavier, but only as being slightly heavier.

FIGURE OF MERIT DEVELOPMENT

In considering the quality of seeing through aberrated lenses, it has always been difficult to visualize the appearance of an aberrated image as it appears to a patient who has no accommodation, since almost all of us have some accommodation. We know that we can tolerate, for brief periods anyway, ⅛ to ½ a diopter of power and astigmatism. It is also hard to visualize what chromatic aberration, particularly what lateral color, will do to one's field of view. Therefore, before going into that part of the paper which discusses the relative merits of the various lenses under consideration, some analysis of the basis of evaluation is necessary.

If one could arrive at a single index of quality which would identify at a given field of view the degree of blurredness, or degree of lack of recognition of detail which a cataract patient would experience when looking through a lens at this field of view, one would have something which would be convenient in comparing one lens with another. To this end, we have attempted to use what we call "Figure of Merit." This expression was first developed and used by the American Optical Company, Lens Division Development Group under D. B. Whitney.

This group developed a "Figure of Merit" which one obtains by adding 2/3 the average curvature to the astigmatism. The reasoning underlying this method of evaluation being related to the fact that the ordinary eye possesses the power of accommodation and thus partially compensates for curvature. Actually, this is a figure of de-merit, since the higher aberrations give a higher numerical value to the figure.

Since the aphakic eye is lacking in accommodative power, it has been necessary to develop a new "Figure of Merit" for cataract lens comparisons. The basis for the "Figure of Merit" used throughout this report is strictly geometrical and is roughly equivalent to the size of the circle of least confusion.

To be valid, the "Figure of Merit" must assign equal values to various combinations of aberrations which appear equally poor to the eye. For example, one cannot differentiate readily among the aberrations introduced by the following lenses: ±1.00 D. sph.: ±1.00 D. cyl.: +1.00 D. sph. ⌒ —2.00 D. cyl.: The new "Figure of Merit" takes

twice the largest field error and shows the above-mentioned combinations to have approximately the same value.

To verify these conclusions, Kodacolor, Ektachrome, and Black and White pictures were taken with lenses in front of the camera that produced various combinations of aberrations. Visual observation and a study of the color prints led to the conclusion that 0.3 prism diopter of lateral color* is about as objectionable as 0.5** diopter of cylinder or power error. Adding the color error to the power error, the complete "Figure of Merit" is taken as being: (Power error in worst meridian) +3.33X (prism diopters of lateral color).

In order to further appreciate what the cataract patient sees, corneal lenses were made to fit the authors to create a 12.00 D. and 14.00 D. hypermetropic refractive error, so that some of these cataract lenses might be worn by the authors, and enable them to appreciate what the cataract patient has to contend with.

Wearing these lenses, we verified that later color, not axial color is annoying, that the limited field of view combined with the magnification of the cataract lenses destroyed one's sense of orientation. It is worth noting that this same thought is expressed in the early German literature on the subject. Loss of orientation was particularly bad with lenticular lenses. We bumped into door frames when going through doors, etc.

FIGURE OF MERIT AS A FUNCTION OF FIELD OF VIEW

A comparison of the representative cataract lenses with respect to field of view has been made. The values of Figue of Merit for rays approaching the lens from the ocular side at angles of 10°, 20° and 30° were obtained for the regular —3.00 base singlet lens, achromatic lens and the corrected curve achromat lens. These values were plotted against the angles for which they were obtained with the resulting graph shown in Figures 7 and 8.

If one takes a Figure of Merit value of 1.5 as the upper limit for reasonable performance, then the graph enables us to determine the largest attainable apparent field angle. From the graph, we see that the regular —3.00 D. base singlet lens has a usable apparent field of 17.5°. By using a doublet as with the achromatic lens, this field has

*If when viewed through a lens, the spread between the blue and the red line in the image of a white line object is 1/100th of the object distance, then the lens, by definition, has 1 prism diopter of lateral color.

**Depending on orientation of cylinder axis, frequently a cylinder error will give more information than a sphere error.

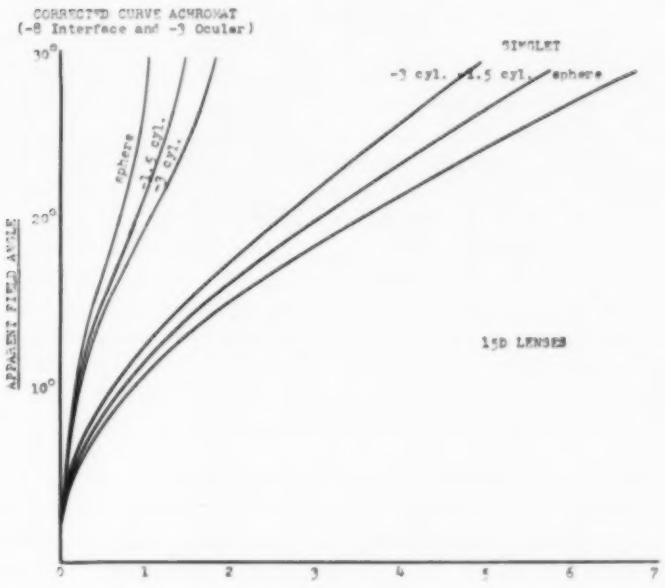


Fig. 8.

been sligthly extended. The use of the corrected curve achromat, on the other hand, permits a usable field which does not exceed the 1.5 limit at 30° apparent field.

Although the bulk of the consideration of marginal errors in cataract lenses has been with relatively crude corrections at wide fields of view, it is to be expected that greater improvement is possible for smaller fields.

Figure 9 illustrates the area of lenses within which the power and astigmatic errors are less than 0.25 diopters for various lenses.

DESIGN OF A CORRECTED CURVE

COLOR CORRECTED CATARACT LENS SERIES

The survey of possibilities of a cataract series employing the corrected curve achromat principle was undertaken primarily for two reasons. First, it seemed advisable to actually demonstrate the possibility of such a series, i.e., to show there is nothing inherent in the corrected curve achromat principle that precludes its use for a complete lens series. Second, the question of economy from the standpoint of the required number of blanks, for a complete series, seemed worth investigating.*

*These blanks would have convex and interface curves finished.

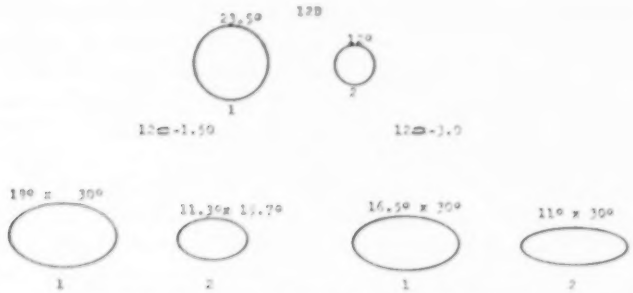


Fig. 9. Apparent field of view of cataract lenses. (1) Corrected curve achromat. (2) Achromat, similar to regular products, i.e., single lens. (All minus cylinder axis, 90°.) The above is a *one-half* size scale drawing of the areas within which powers and astigmatic errors are less than 0.25 D.

For the sake of simplicity, a strictly spherical series will be considered first.

Using as a performance criterion, the Figure of Merit value of 1.5 at 30° field angle, a largely graphic method of design was used.

First, graphs were made by plotting field error, primary and secondary, versus total power of the lens for several interface and back curves. This was done for interface values of three, six, and nine diopters keeping a particular ocular curve: the variation in power being obtained by arbitrarily choosing convex front curves. Similar operations were performed for ocular curves of minus 2.5 diopters, minus 3 diopters and minus 3.5 diopters. The information for the graphs, i.e., values of field error, were obtained by ray tracing. The rays were traced at an angle of 30° from a point 27 mm back of the vertex of the rear surface out through the lens. Then by tracing back along the ray, the primary and secondary focii were determined for this field angle.

The lateral color was also obtained for each ray traced. We then had graphical information as to field and color errors in any combination of power, interface and back curve.

By replotting graphs, we could filter this out for any given power, combine lateral color with the marginal power errors and plot figure of merit curves which shows how this combined value varies with interface for a given power and ocular curve. The graphs were then combined to form one which showed the possibility of a lens series. We could study the overlap portions of interface curves and plan a series based on one front over a range, with one interface, controlling the prescription with the back curve.

TORIC LENS SERIES EMPLOYED THE CORRECTED CURVE ACHROMATIC PRINCIPLE

Toric corrections comprise an important portion of cataract prescriptions and must be considered when the feasibility of a proposed lens series is being studied. The task of designing a complete lens series, on the other hand, does not come within the scope of this report and has not been undertaken. Several examples were, however, developed for demonstration purposes. The cases considered were for lenses having minus cylinders of —1.5 diopters and —3.0 diopters.

The approach to the problem of designing a toric series parallels that used for the development of a strictly spherical series. As before, rays were traced through the lenses considered and the field errors for these rays determined. Again, three interface values were used for each power lens. The information obtained from the ray tracing computations was used to plot a series of graphs as described for the strictly spherical series.

Although the sequence of plottings remained the same as for the spherical series, the procedure for determining the Figure of Merit for torics was necessarily different. For toric corrections the Figure of Merit is obtained by summing the largest error, either "S" or "T," for each of the two points of the toric and adding the lateral color component. The color component is obtained by multiplying the average value, in prism diopters, for the two points of the toric by the figure 3.33.

OPTICAL COMPARISON OF THE VARIOUS CATARACT LENSES

One of the main purposes of this section of the report is to compare the optical performance of the various cataract lenses which have been discussed.

Ideally, the comparison should be made by the aphakic eye. A somewhat less ideal, but practical, alternative is to substitute a camera for the eye with the usual objective lens of the camera being replaced by the cataract lens under study. In order to reproduce the aphakic eye more fully, certain other modifications to the camera must be included. The camera's stop is placed so that it corresponds to the center of rotation of the eye, and the aperture of the stop is adjusted so that it is proportional to an eye pupil size of 7 mm.* Another essential modification is to have the film curved about the center of rotation, in the horizontal meridian, so that it simulates retinal curvature.

*A 7 mm pupil size was selected rather than the generally used 5 mm size because pupil size tends to enlarge after a cataract operation and study and discussion with optometrists showed 7 mm to be a reasonable figure.

Using this modified camera with the cataract lenses under test as objective lenses, photographs were taken.* These photographic tests were made with the target at reading distance and in the distance. In order to make apparent in the photographs any color aberrations introduced by the lenses, a panchromatic type film was used throughout the tests.** In addition to testing the various lenses for the two object distances, the influence of pupil size on image quality was studied using the regular —3.00 base singlet lens as the photographic objective. Extreme pupil sizes, corresponding to eye pupil sizes of 3 mm and 10 mm were used for these tests. This procedure demonstrated that the new corrected curve achromatic lens with a 7 mm pupil is superior to the regular —3.00 base stock lens used with a 3 mm pupil size.

CREDITS

This project was carried on by the following people as indicated.

J. K. Davis, Gilbert Clotar—Overall direction, computing, design of demonstration and photography.

J. M. Dunn—Computing, photography and organizing final report.

R. E. Tibbetts—Computing.

Mrs. Irmgard Luneberg—Translation of German Literature.

We are also indebted for considerable advice from Dr. E. D. Tillyer, Dr. Oscar W. Richards, and various members of the Lens Division Development Group.

REFERENCES

1. E. Hertel, Concerning the Practice of Anastigmatic Cataract Lenses. Berichte der Ophthalmolog Gesellschaft, Heidelberg, 1908, pp. 32-38.
2. "Zeitschrift fur Ophthalmologische Optik," Vol. 5, pp. 26-32—H. Boeghold, "A. Klughardt, About Cataract Lenses." Deutsche Opt. Wochenschr. 1915/16, pp. 393-395 (Apr. 2), pp. 409-411 (Apr. 9), with 3 fig.
3. M. V. Rohr, About Astigmatic Eyeglasses With Point-to-Point ("punktuell") Imagery. Berichte der Ophthalmolog. Gesellschaft, Heidelberg, 1912, pp. 94-100.

*At the Academy meeting the authors presented a number of these photographs which could not be included in this published report.

**Films used were Kodak Contrast Process Panchromatic Film for the reading distance pictures and Ansco Isopan for the distant object pictures.

AMERICAN JOURNAL OF OPTOMETRY
and ARCHIVES *of*
AMERICAN ACADEMY OF OPTOMETRY
Established 1924

Vol. 33 December, 1956 No. 12

EDITORS AND STAFF

Dr. Carel C. Koch ..... *Editor*
Dr. Monroe J. Hirsch ..... *Associate Editor*
Dr. Rudolph Ehrenberg ..... *Associate Editor*
Terry Judith Parkins ..... *Editorial Assistant*

Publication and Academy Office: 1508 Foshay Tower, 821 Marquette Ave.
Minneapolis 2, Minnesota

Annual Subscription, United States and Canada, $7.00 in Advance; Foreign, $7.50
Single Copies 70c

Original papers, scientific communications, clinical reports, books for review, and correspondence should be sent to the editor. Subscriptions and applications for single copies should be addressed to the circulation manager. Copy of advertisements must be sent in by the first of the month preceding their appearance. Communications with reference to advertising or other journal business should be addressed to the advertising manager. Academy correspondence should be addressed to Dr. Carel C. Koch, Secretary of the American Academy of Optometry.

Published Monthly by the
AMERICAN JOURNAL OF OPTOMETRY PUBLISHING ASSOCIATION

The American Academy of Optometry and the publishers of this journal have no objection to the reprinting by other magazines of any of the articles in this issue, provided such reprints are properly credited to the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

COMMENTS ON REDUCED ENROLLMENTS

The problem of getting college students that have at least two or more years of proper undergraduate studies to enroll in our optometric courses, has been with us for several years. It was expected that the September, 1956, enrollment would show an improved change in the recent trend, but in this, we were disappointed. The number of inquiries received at our schools was up from preceding years, but the actual enrollment did not meet expectations. This fact has served to unnecessarily concern optometrists.

While we would all like to see a larger enrollment in schools teaching undergraduate optometric professional work, we must view the overall current educational picture to get the optometric part into true focus. At the end of World War II the supply of prospective students, with government aid, far exceeded the facilities of all professional schools and enrollment everywhere soared to all time highs. This group of students is now out of college and in their places are students who were and still are being pressured to go into schools of technology rather

than the healing arts sciences. This trend has had its effect on most undergraduate professional enrollments, not only in optometry, but in other areas as well.

According to Bulletin No. 39, of October, 1956, dealing with Minnesota's Public Educational System,[1] the University of Minnesota, College of Medical Sciences, provides instruction in medicine and in a number of special fields including public health, medical technology, nursing, hospital administration and physical and occupational therapy. Enrollment in the medical school and its related schools and courses dropped from 1947 to 1951, but the major loss occurred in the school of nursing. From 1952 to 1955 enrollments continued to drop except in the school of nursing where they increased from 290 in 1952 to 416 in 1955. This increase may be due to the policy of the state legislature in granting scholarships for nurses. In the school of pharmacy at the University of Minnesota the enrollment dropped from 327 in 1952 to 154 in 1955.

The University of Minnesota is not alone in this trend. Similar excellent medical schools report these trends and to offset this, many of these healing arts educational centers are now enrolling students with C-grade averages, a thing unheard of several years ago when there were more applicants than openings.

These reduced enrollments at medical schools are also playing a part in reduced enrollments at our optometric schools. When medical enrollment was high, the number of applicants far exceeded the openings, and a number of candidates who sought medical school enrollment without success, entered optometric professional educational centers. Today this source of prospective student is non-existent as most students can find places in the undergraduate medical schools of today if they wish to do so.

In addition, the temporary, though country wide pressure upon the young male high school student to enroll in some form of engineering, also has its effect upon our present day enrollment. This is true not only in optometry but in the entire field of healing arts. However, these are temporary trends in modern education and are subject to change. In fact, they will change drastically and when this change comes we will find our own optometric enrollments again rising to most satisfactory levels.

In the meantime we should employ all proper methods of improv-

[1]Minnesota Taxpayers Association. Minnesota's Public Educational System. Bulletin No. 39. Page 21. 1956. St. Paul, Minnesota.

ing enrollment in our own splendid schools and colleges. This may be done as individuals, discussing this subject with students as we meet them. And too, it should be done as an organized effort at the local and state association levels. This is an activity in which every optometrist may do his part.

CAREL C. KOCH

MERRY CHRISTMAS

At the end of thirty-three years of editing and publishing this optometric magazine, we again pause to give thanks, at this Christmas Season to our many friends for their constant help and encouragement. Without these friends throughout the profession and optical industry no venture of this kind could have been successfully launched, nor could it have continued, in good times or through periods of great stress. And so in the Christmas Season of 1956 we again say to all, your help over the years has encouraged us to carry on and has been an inspiration to us. For all of this we are deeply grateful and to our friends throughout the world we send our Greetings and Best Wishes for the finest and merriest of Christmas Seasons.

THE EDITORS AND STAFF

SPECIAL REPORT

JOHN BENSON — 2ND LORD CHARNWOOD, 1901-1955

In this article Sir Arthur Bryant* pays a moving tribute to an old friend of his who died in 1955 — John Benson, 2nd Lord Charnwood. He was a man of outstanding gifts and high courage who fought against physical suffering and disadvantages. "Original, fearless and utterly honest," writes Sir Arthur, "he followed always his own bent, which led him far, and to the enrichment of his fellow men, from the beaten path which, from the circumstances of his birth and upbringing, he might have been expected to follow. He became all that a man should be—just, honourable, gentle, generous and brave." Lord Charnwood

*THIS REPORT IS REPRINTED FROM THE NEWSLETTER OF THE ASSOCIATION OF OPTICAL PRACTITIONERS, LONDON. IT FIRST APPEARED IN THE ILLUSTRATED LONDON NEWS, JULY 2, 1955. WE ARE PLEASED TO REPRODUCE THIS MATERIAL BY SIR ARTHUR BRYANT AT THE REQUEST OF THE MANY FRIENDS LORD CHARNWOOD HAD IN THIS COUNTRY AND CANADA. HE VISITED US ON SEVERAL OCCASIONS AND MADE MANY FRIENDS AMONG OPTOMETRISTS AT ANNUAL ACADEMY MEETINGS. HE WAS A MEMBER OF THE AMERICAN ACADEMY OF OPTOMETRY AND THE BRITISH CHAPTER, AMERICAN ACADEMY OF OPTOMETRY.

was a brilliant motor-engineer, and a courageous soldier, and was also "a most versatile and accomplished craftsman, practising, among other things, with exquisite skill, the hobby of horology. . . ." After the war he qualified as an optometrist, practised in London, and joined the staff of the London Refraction Hospital. " 'In less than eight short years,' the Secretary of the Bristish Optical Association wrote after his death, 'he made an impact upon the profession that was almost meteoric, so quickly did he make his mark.' " This remarkable man was born in 1901 and educated at Eton and Balliol. Commissioned in the Bedfordshire Yeomanry in 1929, he served in the Second World War with the Royal Artillery. He succeeded his father in 1945.

Courage, James Barrie wrote, is "the lovely virtue." It is the virtue without which, in this world, at any rate—in some other, through God's mercy, it may be otherwise—all the other virtues are unavailing. For the essence of this world is difficulty, often immense and seemingly insoluble difficulty, and human beings can only survive and make their way in it at all by overcoming difficulties. The greater those difficulties—and as life continues they tend to thicken and grow worse—the greater the courage needed to overcome them. And the greatest and last of human difficulties is death itself. That, too, though it cannot be avoided, can be overcome, and by courage.

I was reminded of all this by the life-story of an old friend who died earlier this year. John Benson, 2nd Lord Charnwood, was the younger and only surviving son of two brilliant and literary parents—the one a Balliol don who entered Parliament and became the author of what for many years was the standard, and is probably still, the best single-volume life of Abraham Lincoln; the other a woman of great intellectual power and dominating personality who wrote several books herself, one of them containing one of the finest descriptive passages about listening to music in English literature. I was devoted to them both, for, when I was young, they were very kind to me. John was a few years junior to me, but at the same preparatory school, and a great friend of my younger brother. At that time he was a big, overgrown, rather sentimental boy, who suffered a good deal of ragging at the hands of his more normal contemporaries. He shambled about rather than walked, and talked with a lisp; we knew he was a semi-cripple, but were unaware that he had been stricken with polio at the age of five and that much of his early boyhood had been spent on crutches. Nor did we know that he was in almost constant pain and had had to have the tendons on his feet frequently cut. Nor did his disadvantages end there. When he went to Eton and later to his father's old college of Balliol, he showed a constitutional inability to pass examinations

in the kind of subjects in which, as his parents' son, he was naturally expected to excel. In fact, to the narrower, more pedantic kind of conventional mind, he must have appeared an idle, stupid lad, incapable of application or serious thought. It was partly that he had outgrown his strength— he was six foot four; partly because his strong instinct for independence caused him to react stubbornly against well-meant but over-zealous attempts to make him conform to what was expected of him.

At that time I lost touch with him, for I had gone to a rival school and then into the Army. When I met him again, at a time when I used to go to dances with his two pretty and talented sisters, he was still an overgrown giant crippled by a heavy limp, but the softness and outward sentimentality which I had earlier associated with him had vanished. Instead, he had become something of what we should now call a "tough": a big, hearty fellow, with very pronounced views of his own and not very much respect for any one else's. Though with the kindest of hearts under his shambling, bearlike exterior, he made his way about the world like a battering-ram. We spent a holiday about that time in Germany together, visiting the opera and picture-galleries at Dresden, and I can still see him, a giant in an astonishing check suit, which he had bought, I believe, in some junk-shop for £3, and at whose appearance and that of a frightful cap that crowned it, every Dresdener within a hundred yards of us would stop and stare. As we were nearly always involved in vehement controversy, I think the inhabitants must have supposed us to be some sort of itinerant international delegation from the wilder part of the Balkans. He was certainly an original and like no one else in the world.

I knew he was interested in motors and that he spent—wasted, was how it seemed to my youthful and priggish mind—most of his time on them. In fact, and at that time it was quite an original thing for a young man in his circumstances to be, he had, to the great disappointment of his parents, become a motor-mechanic, going through his apprenticeship in the shops. What I did not realise, for it was a subject of which I was profoundly ignorant, was that he was a brilliant motor-engineer. Shortly afterwards he became chief-engineer to the firm of Bamford-Martin, the original makers of the Aston-Martin racing car. At the time he joined the firm there was an epidemic of cracked chassis-frames, which always broke in the same place, and which he cured, with characteristic originality, not by strengthening but by weakening the faulty point and so eliminating the stress-concentration. Later, he undertook research work for the London Omnibus Company. He was also a most versatile and accomplished craftsman, practising, among

other things, with exquisite skill, the hobby of horology, of which he became a great enthusiast.

During the latter 'twenties and 'thirties I once more lost touch with him, hearing of him only through his sisters. But I learnt, much to my surprise, that he had become a distinguished connoisseur of claret; that he was writing musical criticisms for THE TIMES and DAILY TELEGRAPH; that despite his lame leg he had joined the Yeomanry; and that in 1938 he had fitted up a thirty-year-old, 44-ft. Cornish lugger for a voyage round the world, in which he had set out to circumnavigate the globe. In September, 1939, he was recalled to his unit just as he was about to set sail from the Peruvian coast to Easter Island. The next that I heard was that he had been wounded at Dunkirk, bringing back, with his customary skill and resource, an abandoned vessel which he had made seaworthy and filled with stranded soldiers.

For the rest of the war, being incapacitated, he served with the Experimental Establishment of the Coast and Anti-Aircraft Artillery. His duties in training stereoscopic range-finders led to his first experimental work on the subject of vision. It was this that caused him when the war was over to become a student in the Optics Department of the Northampton Polytechnic and to embrace, in his middle forties, a completely new profession. Qualifying as an optometrist, he practised in London and joined the staff of the London Refraction Hospital. "In less than eight short years," the Secretary of the British Optical Association wrote after his death, "he made an impact upon the profession that was almost meteoric, so quickly did he make his mark." His essay on Binocular Vision, published in 1950, received wide recognition, both in this country and America, and won him the Master's Prize of the Worshipful Company of Spectacle Makers and, in 1953, the rare award of the British Optical Association's Research Medal. He himself, with his habitual modesty, described his work as "a record of unrelated small attacks on a number of facets of the problem of how the brain contrives to drive the two eyes in double harness." But those attacks achieved something of lasting value in alleviating the human lot, and, had they been continued, they might have earned for the brave and brilliant man who made them fame of an even wider kind.

Yet those who remember Lord Charnwood most vividly are the poor and old among whom he practised and to whose service he brought a wonderful tenderness, patience and gentleness. Having had so much to overcome in himself and in his own physical handicap, he had acquired with the years a deeply moving strength and generosity. Though I had heard, and with astonishment, of his new profession and the distinction he was winning in it, I only saw him once in these years.

when, late for an appointment, I stopped a solitary car in the street in a snowstorm and asked for a lift, which was given with a rare and charming courtesy. I was immensely struck by the driver's face, its strength, humorous wisdom and kindliness, but only when I was about to alight did I recognize my old friend or he me. I never saw him again. Last summer, just as he was about to attend the International Ophthalmological Congress in America, he developed an obscure and fatal disease which first paralyzed, and then rendered him speechless, and of which, after a long and painful illness, heroically borne, he died early this year.

Looking back, one can see that his whole life was a struggle in which exceptional talents were for long concealed and at first all but suppressed by exceptional difficulties: difficulties against which he had continually to contend and which in the end he triumphantly overcame. His struggle against ill-health and pain strengthened and sharpened his courage to the finest edge, yet never robbed him of the sweetness and gentleness that was at the core of his nature. Original, fearless and utterly honest, he followed always his own bent, which led him far, and to the enrichment of his fellow-men, from the beaten path which, from the circumstances of his birth and upbringing, he might have been expected to follow. He became all that a man should be—just, honourable, gentle, generous and brave. His last whispered words, caught by his sister and his nurses as he lay dying, were "It doesn't matter." In a sense it doesn't, for by his life of courage, he had triumphed over himself and, in the end, over death itself.

EPILOGUE. To those of us in the United States and Canada, who knew Lord Charnwood as an optometrist during the latter years of his life, this beautiful testimonial by Sir Arthur Bryant awakens many pleasant memories of the man and the time we spent together at various Academy meetings.

It brings to mind the gracious manner in which he met every situation, and the way he coupled this with his robust, two-fisted brand of good fellowship—which at first startled a newcomer but fast won him over. It brings to mind his deep understanding of the basic fundamentals underlying refractive work and his ability to get his viewpoint across. He was at his best in a small group whose opinions he valued. It was at these informal gatherings that he made many lasting friendships and won much admiration for his fine background in matters pertaining to binocular vision.

This tribute to Lord Charnwood, or "John" as he was called by many of his friends in America, also brings to mind instances that taught

us that he could play, just as hard as he could work. During his first visit to Chicago he gravely explained that he was a bit apprehensive in coming to a city so famous for its gangster and hoodlum element. Our meeting that year was in the Palmer House. One evening during the meeting, about midnight, we decided to stroll over to the Tip-Top Inn, then near the Morrison Hotel, for a steak. As we rounded a corner we were startled to see a man shoot another and watch him drop to the pavement. Lord Charnwood was not at all surprised and none of us were ever able to convince him that what we had seen was not an hourly experience in the Loop. He was even surer of himself the next day when no mention of the shooting appeared in the papers.

At another meeting he had a good time pulling-the-leg of his audience when, during a Round Table banquet he gravely explained to them that he insisted on having a drink with the first and last patient each day. That story also reminds me of the occasion in Cleveland when we dashed around town in a cab early one Sunday morning with a motorcycle escort searching for a particular brand of imported gin. We had run out, and Lord Charnwood could never understand our local habit of putting ice and water in glasses.

It seems like yesterday when I saw him last. It was in New York City. Our convention had ended and we stayed on for a day or so to make plans for the future. These plans never materialized, but our association and friendship will always remain one of my very fine optometric experiences. I know most will agree when I say that optometry everywhere suffered a grave loss in his passing.

CAREL C. KOCH

AN EVALUATION OF THE MECHANICAL ASPECTS OF HEARING-AID SPECTACLES*

WITH SPECIAL REFERENCE TO QUALITIES DESIRABLE FROM AN OPTOMETRIC VIEWPOINT

Monroe J. Hirsch†
Ojai, California

Since their introduction about a year and a half ago, hearing-aid spectacles have presented optometrists with a problem. This problem, of course, is one of determining the attitude of the optometrist toward

*Submitted on November 2, 1956, for publication in the December, 1956, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Optometrist, Ph.D., Fellow, American Academy of Optometry.

these glasses and his role in fitting them. At Milwaukee in 1955 the American Optometric Association by resolution stated the policy presently followed by most optometrists. This policy is, in essence, one of cooperating in so far as the visual aspects are concerned, but not engaging in any of the hearing aspects and not entering into a dealer or agent relationship with any hearing-aid manufacturer.

More recently, this thinking was expanded upon and presented to the profession by Tillisch and Koch.* In September of this year the Tri-County (California) Optometric Association invited representatives of various hearing-aid companies to present their programs. Representatives from four companies appeared and as each presented his ideas, it became obvious to the author that the structure of the various types of aids made some of these more suitable than others for optometric cooperation. It is the purpose of this report to describe the physical characteristics of the various types of hearing-aid spectacles with particular reference to the ease with which they would fit into a program which optometrists could consider ideal.

At the outset, the conditions which allow for the most nearly normal doctor-patient relationship should be outlined. These are the following:

(1) All of the optometrists' dealings should be with his patient; and the optometrist should have as little relationship as possible to any manufacturer of hearing aids.

(2) The division of responsibility should be clearly established in the minds of the optometrist, the hearing-aid representative, and the patient.

(3) The optometrist should have a choice of materials sufficiently great to enable him to interpret properly the visual correction. To illustrate this point, it should be noted that certain of the hearing-aid eye glass frames do not have adjustable pads. Koch** has recently pointed out that a frame with such pads is desirable for patients wearing bifocals. It would then be undesirable for an optometrist to find it necessary to place bifocal lenses in a hearing-aid frame with rigid pads were this not his customary practice.

In the light of these conditions we may now consider the various types of hearing-aid spectacles. It should be pointed out that there are over 150 different companies making aids at the present time. For this reason, the names of companies are not mentioned, but rather the types

*Tillisch, Arthur E. and Koch, Carel C., The Optometrist in a Program of Hearing Aid Spectacles. Am. J. Optom. & Arch. Amer. Acad. Optom. 33: 500-505, 1956.
**Koch, Carel C. Minor Suggestions to Improve Refractive Care. Am. J. Optom. & Arch. Amer. Acad. Optom. 33: 15-23, 1956.

into which most of these aids fall. These various types are:

A. *Those aids which are constructed so that both temples and the front are an integral part of the hearing device.* A number of aids are constructed on this principle. The temples are quite thick and usually hollow. The hinges are used to make contact so that when the temples are closed the hearing-aid is off; when the aid is being used, the contact has been made by spreading the temples. This type of aid presents the greatest number of difficulties to the optometrist. The manufacturer usually suggests that the optometrist perform the examination, take frame measurements, order the lenses, and submit the frame measurements to the hearing-aid representative. The hearing-aid representative then fits the patient with a frame embodying the hearing-aid. The patient takes this to the optometrist who then inserts the lenses in the frame and adjusts it.

The difficulties in such a plan are apparent immediately. Many optometrists, particularly in fitting bifocals, like to take the measurements for placement of the bifocal segment through a sample of the actual frame that will be worn. This difficulty can be overcome by having the patient make one additional trip. The optometrist could, upon completing his examination, state the size of frame which he *thinks* he will require. The patient could then bring this frame from the hearing-aid representative to the optometrist who could then take bifocal placement measurements through this frame. Then the subsequent steps could be as listed above.

The question of division of responsibility when using this type of hearing-aid spectacles becomes quite complex. If the frame is an ill-fitting one, upon whom shall the patient place the blame? The frame was supplied by the hearing-aid manufacturer but was not rejected by the optometrist. Or, what happens if the optometrist will not accept the hearing-aid frame? The question may also arise as to whether the optometrist is now responsible for keeping the frame in lifetime adjustment.

These and other similar problems will arise in the fitting of this type of device. Probably, each of the problems can be solved, but it should be noted that this type of device brings about the most complicated of the possible relationships between patient, optometrist, and hearing-aid representative, and, therefore, is least desirable unless its auditory characteristics are much superior to other types of device.

B. *Hearing-aid spectacles in which a special hearing-aid is joined to a standard optical frame front in a special manner.* In this type of hearing-aid, the optometrist is requested to supply both the lenses and

the frame front. The hearing-aid is contained in the temples and, in addition to being connected to the front at the hinge, these temples must be joined by a wire passing across or through the frame front. This type of hearing-aid device removes some of the difficulties to be found in the first one described. One manufacturer presenting this concept suggested two possible plans for cooperation between optometrists and hearing-aid representatives. In the first of these, the optometrist would supply frame front and lenses to his patient who would, in turn, take this to the hearing-aid representative. The temples would be fitted and attached by the hearing-aid representative. Under this plan, the responsibility of each party is a little more clearly defined than in the first type of aid described. The second plan would be one in which the optometrist fitted the front and the hearing-aid representative supplied the temples, connecting pieces, and instructions for assembly to the optometrist. The optometrist could then assemble the glasses and fit them to the patient. For this service the company would pay the optometrist a fee.* If one is seeking complete divorce of the optometrist from the hearing-aid aspects of the device, then this second suggestion is the less desirable of the alternatives offered by the manufacturers of this type of device.

C. *Hearing-aid devices which are fitted to an existing pair of spectacles.* This type of aid offers the greatest possibility for a complete separation of the optometrist from the hearing-aid aspects. The hearing-aid is either incorporated in a single temple or pair of temples which are in no way joined to each other through the front of the spectacles. At least one manufacturer offers a device which can be fitted to the end of a regular zylonite temple. Were such a device to be used, the optometrist would treat his patient exactly like any other patient. The only limitations placed upon the optometrist might be in choice of color of the frame. If such a device is used, the optometrist completes his examination and orders for his patient standard ophthalmic materials, or the patient may continue using his own spectacles if he does not need new ones. The patient, under this situation, is completely aware of the responsibility of the optometrist and the responsibility of the supplier of the hearing-aid device. If, after the hearing-aid has been supplied, the patient is in any way dissatisfied, the optometrist is in no way involved, for his responsibilities have already been satisfactorily discharged.

GENERAL CONCLUSIONS

It is the conclusion of the present author that this third type of

*This plan was described in the article by Tillisch and Koch.

device described is the most satisfactory from the optometric point of view. Whether a hearing device is fitted or not in no way changes the basic service which the optometrist is offering. The relationship between the optometrist and his patient who desires a hearing device is identical to that of any other patient.

It should be noted in passing that no attempt has been made by the author to determine which of the various aids had the best properties in so far as hearing was concerned. It may be that at the present state of development certain of these aids are more satisfactory than others. Certainly, those described under the first section above are the most costly and the most complicated. On the other hand, the manufacturers of hearing-aids should realize the desires of optometry: First, to retain the doctor-patient relationship enjoyed by all other patients; and, second, to establish as clearly as possible the responsibilities of the optometrist and of the hearing-aid representative to the patient. The more the optometrist can divorce himself from the hearing-aid aspects, the more he is able to retain his role of vision specialist and the more he is able to establish clearly in his patient's mind just what his responsibilities are. It is not the intent of this report to suggest that optometrists recommend one type of aid or another. However, manufacturers of hearing-aid glasses should realize that with certain types of aids, optometrists are better able to retain their customary doctor-patient relationship than they are with others. Other things being equal, these are the types of aids that will be in the best interest of all concerned.

ERRATA

THE HELMHOLTZ CHECKERBOARD PATTERN*

Glenn A. Fry†
The School of Optometry
The Ohio State University
Columbus, Ohio

In a previous paper[1] reference was made to the Helmholtz checkerboard pattern which compensates for the barrel distortion of visual space. The following equation expresses the perceived displacement of an object toward the center of the visual field:

$$\tan \mu' = 2 \tan (\mu/2). \qquad (1)$$

In the previous paper, an error had been made in transcribing this formula and it was printed as

$$\tan \mu' = 2 \sin (\mu/2).$$

The derivation of Equation (1) is illustrated in Figure 1. $\overline{P}$ is the

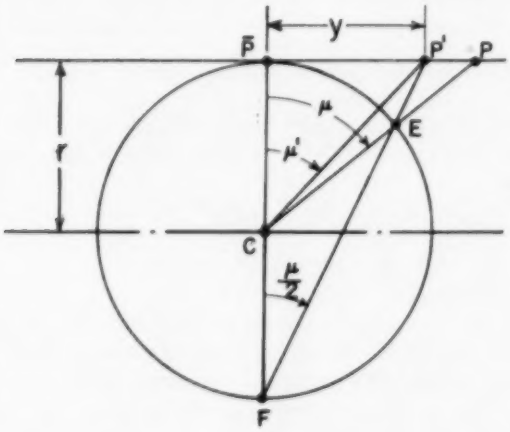


Fig. 1. Helmholtz' conception of the relationship between perceived and physical directions of a peripheral object.

[1]G. A. Fry. The Relationship Between Perceived Size and Perceived Distance in the Periphery. Am. J. Opt., 33, 477-482 (1956).

*Submitted November 7, 1956, for publication in the December, 1956, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Optometrist. Ph.D., Director of school. Fellow, American Academy of Optometry

point of fixation. C represents the point of observation, P is an object at any point on the flat surface normal to $\overline{PC}$ at $\overline{P}$ and P′ is the perceived image. E is a point on the sphere entered at C and tangent to the flat surface at $\overline{P}$. It lies on the line between C and P. The perceived image P′ lies on the line FE. Equation (1) follows from the fact that

$$\tan \mu' = y/r$$

and that

$$\tan (\mu/2) = y/2r.$$

The writer wishes to express his appreciation to Mr. A. G. Bennett for calling his attention to the error which appeared in the previous paper.

TRANSACTIONS OF THE AMERICAN ACADEMY OF OPTOMETRY

A department devoted to announcements, reports, appointments, organization data, news, professional problems and ideals, as these relate to the Academy.

ANNUAL REPORT OF SECRETARY-TREASURER*

Carel C. Koch†
Minneapolis, Minnesota

We are now concluding the 35th year of the Academy. This is our 36th meeting, and again I am pleased to report to the membership that the affairs of the organization are in order.

FINANCIAL POSITION OF THE ACADEMY

The Secretary-Treasurer's report which was mailed to the membership on November 10, 1956, reviewed the current fiscal position of the Academy. While this position was good, there is room for improvement. During the past year, all current needs were met without difficulty by the Academy, but during the same period of time your officers and Executive Council have found themselves short of funds for worthwhile special projects, and our reserves which may be used for

*Read before the annual meeting of the American Academy of Optometry, Houston, Texas, December 8, 1956. For publication in the December, 1956, issue of the AMERICAN JOURNAL OF OPTOMETRY AND ARCHIVES OF AMERICAN ACADEMY OF OPTOMETRY.

†Optometrist, Fellow, American Academy of Optometry.

grants-in-aid are unnecessarily very limited.

For more than 30 years, the annual dues of the Academy have remained unchanged. This is a very remarkable record among scientific societies interested in educational work, and I am pleased to report to you that at present there is no plan for increasing our annual dues.

Your officers, on the other hand, feeling the need for additional Academy income urge each member to give consideration to the possibility of inviting one or more of his professional friends who would enjoy our program, to become Fellows of the Academy.

While we have never engaged in a membership drive, and are not suggesting one now, we should point out that all of our foreseeable current financial needs would be adequately met by the addition of 200 new members.

We are equally sure that this goal can be reached in the very near future, and at this time, we enlist your active support towards this end.

If you will send the names of proper prospects, with whom you have discussed the subject, to my office, we will send the applicant the necessary follow-up.

MEMBERSHIP

Since our last meeting at Chicago, Illinois, membership certificates have been issued to 64 optometrists, educators and scientists. On November 15, 1956, the membership of the Academy numbered 776. This is the high point in Academy membership. In addition, there are 90 active applications in the hands of our Committee on Admittance.

Since our last meeting, I regret to report that the Academy has lost seven members through death. Each of these men played a significant part in the development of the profession, and each has left his important mark upon optometry. All have been active in the Academy. We miss these important leaders, and at this time we pay our respects to:

Dr. A. B. Jordan, Brattleboro, Vermont.
Dr. George W. Keevil, Toronto, Ontario, Canada.
Dr. Carl A. Radde, Cleveland, Ohio.
Dr. Carl Shepard, Chicago, Illinois.
Dr. Edwin H. Silver, La Jolla, California.
Dr. John A. Steeve, Maplewood, New Jersey.
Dr. E. Gerald Wilhite, Bedford, Indiana.

During this same period, the Academy accepted with regret the resignations of 10 members. These are:

Dr. Kenneth Armstrong, Providence, Rhode Island.
Mr. Albert J. Billson, Ayr, Scotland.

Mr. S. Black, Oxon, England.
Dr. Milton Harman, Geneva, New York
Dr. Henry A. Imus, Bethesda, Maryland.
Dr. Charles E. Jaeckle, East Orange, New Jersey.
Dr. Carl R. Peters, Logan, Iowa.
Dr. Herbert L. Toms, Chapel Hill, North Carolina.
Dr. O. T. Weigmann, Los Angeles, California.
Dr. George C. Wise, Hartsville, South Carolina.

Of these resignations, two resulted, as the members had retired from practice; one as the member returned to school, and another because the member had left the field of optometry. Two others, we believe, resigned because of pressures which developed due to unsatisfactory inter-professional relations that now exist between optometry and ophthalmology. The other four resignations came from optometrists who, while still in practice, were cutting down on their interests and activities as they approached the retirement age.

A WEST COAST MEETING

The Academy has not held an annual meeting on the West Coast since 1939. In that year, a successful meeting was held at Los Angeles. At our meeting in Chicago in 1955 it was proposed that the 1960 meeting be scheduled in the San Francisco Bay Area. This proposal is still before the Academy, and will be voted on at our next annual meeting in Chicago in December of 1957. It is suggested that members discuss this matter at Chapter meetings and elsewhere, and come to Chicago a year from now prepared to vote on this matter. As is already known, the 1958 meeting is scheduled for the Hotel Statler, at Boston.

CONCLUSION

In closing this annual report, I wish to express my deep appreciation to President Perry, and the Executive Council for the fine support they have given me as Secretary. It has been a real pleasure to work with these men. I also wish to thank the Special and Standing Committees for the fine jobs they have done, and to thank the Chapters and Sections for their cooperation. President Perry has been most helpful at all times, and the Academy should be proud of his constructive leadership.

THE INDEX
TO THIS VOLUME HAS BEEN REMOVED
FROM THIS POSITION AND PLACED AT
THE BEGINNING OF THE FILM FOR
THE CONVENIENCE OF READERS.

Mr. S. Black, Oxon, England.
Dr. Milton Harman, Geneva, New York
Dr. Henry A. Imus, Bethesda, Maryland.
Dr. Charles E. Jaeckle, East Orange, New Jersey.
Dr. Carl R. Peters, Logan, Iowa.
Dr. Herbert L. Toms, Chapel Hill, North Carolina.
Dr. O. T. Weigmann, Los Angeles, California.
Dr. George C. Wise, Hartsville, South Carolina.

Of these resignations, two resulted, as the members had retired from practice; one as the member returned to school, and another because the member had left the field of optometry. Two others, we believe, resigned because of pressures which developed due to unsatisfactory inter-professional relations that now exist between optometry and ophthalmology. The other four resignations came from optometrists who, while still in practice, were cutting down on their interests and activities as they approached the retirement age.

A WEST COAST MEETING

The Academy has not held an annual meeting on the West Coast since 1939. In that year, a successful meeting was held at Los Angeles. At our meeting in Chicago in 1955 it was proposed that the 1960 meeting be scheduled in the San Francisco Bay Area. This proposal is still before the Academy, and will be voted on at our next annual meeting in Chicago in December of 1957. It is suggested that members discuss this matter at Chapter meetings and elsewhere, and come to Chicago a year from now prepared to vote on this matter. As is already known, the 1958 meeting is scheduled for the Hotel Statler, at Boston.

CONCLUSION

In closing this annual report, I wish to express my deep appreciation to President Perry, and the Executive Council for the fine support they have given me as Secretary. It has been a real pleasure to work with these men. I also wish to thank the Special and Standing Committees for the fine jobs they have done, and to thank the Chapters and Sections for their cooperation. President Perry has been most helpful at all times, and the Academy should be proud of his constructive leadership.

Thanks and best wishes for a Merry Christmas and a Happy and Prosperous New Year to you, from all of us.

The Minnesota Optical Company

Minnesota Optical Company

Exclusively Wholesale—For the Profession

621 West Lake Street Minneapolis 8

For Your Protection—And It's Important

Therminon LENSES
THERMINON LENSES are made to the exact scientific Therminon formula and absorb infra-red as well as ultra-violet rays.
Your prescription has been ground in
THERMINON LENSES with the precision necessary for your comfort, protection and accurate vision . . . and cannot be duplicated by any other lenses.
For ocular conservation, your eyes should be examined again on....., 19.....

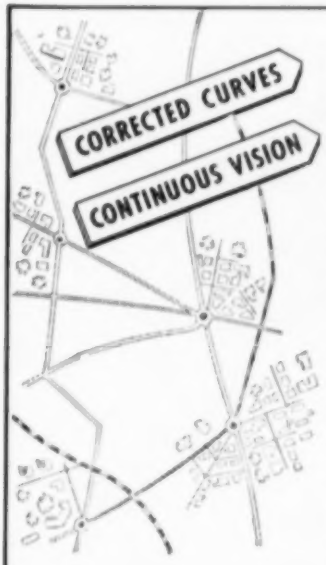
This certificate you receive with your finished Rx protects you, your patient and laboratory. It indicates that your Rx was filled using Genuine Therminon.

RELIABLE LABORATORIES
NEVER DEAL IN IMITATIONS

THERMINON LENS CORP.

63rd and University Avenue, Des Moines, Iowa

NOW you can prescribe from a complete line of Therminon lenses, including all types of Bifocals and Trifocals.



Where do the roads of ophthalmic progress lead?

Scientific progress shows the right roads ahead more clearly with each passing year. This has been particularly true in the ophthalmic field. Those laboratories which have used only the quality products of the progressive manufacturer have found that they benefit and build both themselves and the doctors whom they serve.

This has certainly been true in the case of corrected curve lenses. Progressive laboratories everywhere stress their use—and they mean even more to the doctor and his patients. We lend our voice strongly to this suggestion. It is our firm belief that we serve better by supporting such recommendations.

We also add our voice to those of the increasing numbers who are advising the prescription of Continuous Vision Lenses in the practice of eye care. Produced on the excellent Univis Series of Corrected Curves, CVs represent the ultimate in performance for a substantial percentage of presbyopic prescriptions.

A COMPLETE Rx SERVICE

Twin City OPTICAL COMPANY

MINNEAPOLIS • MINNESOTA • WILLMAR

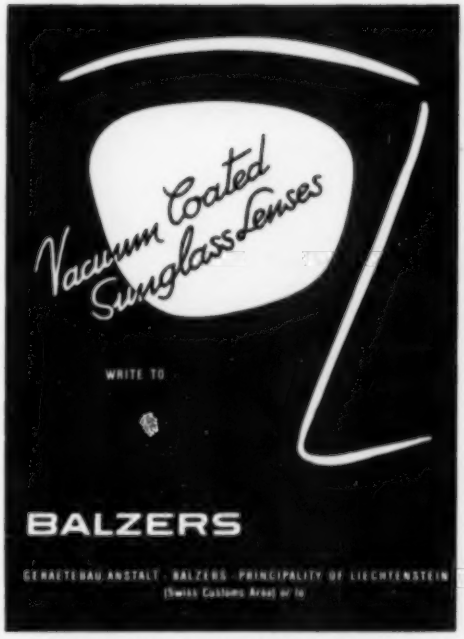
ANNOUNCEMENT BY
Illinois College of
OPTOMETRY

Applications for admission to classes beginning February 4, 1957 and September 9, 1957 are now being received.

Three year course
of professional study
Leading to the Degree of
Doctor of Optometry

Requirements for Entrance:
Two years (60 semester hours or equivalent quarter hrs.) in specified liberal arts and sciences.

WRITE FOR BULLETIN
TO: REGISTRAR
ILLINOIS COLLEGE
of OPTOMETRY
3241 So. Michigan Ave.
Technology Center, Chicago 16, Ill.


Vacuum Coated
Sunglass Lenses
WRITE TO
BALZERS
GERAETEBAU-ANSTALT · BALZERS · PRINCIPALITY OF LIECHTENSTEIN
(Swiss Customs Area) or to
DR. M. VEUVE COCHRAN, 234 S. CHESTER AV., BAKERSFIELD, CALIF.

EFFICIENT — ECONOMICAL — ETHICAL

Glover
FRAME DISPENSING EQUIPMENT
FITTING DESKS
FRAME CABINETS
WALL DISPLAYS
SPECIAL PRESENTATION ITEMS

Guaranteed, quality-built products of unsurpassed workmanship and design.

FRAME-TAINER unparalleled, the most ingenious frame holder ever designed; automatically adjusts for all sizes and shapes of frames. Exclusive in Glover products.

Send your name and address for descriptive catalog to:
GLOVER MANUFACTURING CO.
Box 4093 Austin 51, Texas

GLOVER

Season's Greetings

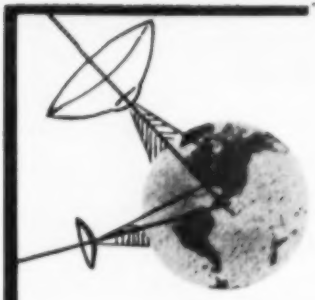
WALCO

SINCE 1915

With our sincere wish
for A Merry Christmas
and a happy prosperous
New Year to you.

CONVENIENTLY LOCATED:
St. Paul, Minn. Austin, Minn. Bemidji, Minn.
Watertown, S.D. Grand Forks, N.D. Billings, Mont.

THE WALMAN OPTICAL COMPANY
229 Medical Arts Building Minneapolis 2, Minn.
FOUNDED IN NINETEEN HUNDRED FIFTEEN



INTERNATIONAL LENS LABORATORIES

Manufacturer of New International Contact Lenses

SUITE 421-140 CADILLAC SQUARE DETROIT 26, MICHIGAN • TEL. WO 3-7368

Fluidless Contact Lenses developed 1927 in Germany

A. Mueller-Welt

Scleral lenses Assymetrical lenses Micro lenses

New B Micro lenses

Rx Plastic and Large Wood

SHOP TRAYS

Now stocked by your Optical Supplier.

Request Specialty Catalogue.

APEX SPECIALTIES COMPANY

1115 Douglas Ave.

Providence 4, R.I.

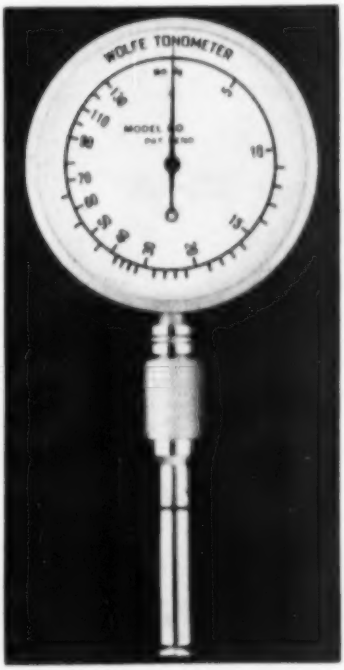
THE CORRECTION LENS

This report deals with the eye as an optical system and the lenses which are used in correcting the deficiencies of this system. The author reviews the mathematical discipline on which lens corrections rest and combines this with the ametropias corrected by these means. Written by Dr. Julius Neumueller, Pennsylvania State College of Optometry. Write for Monograph No. 52. 60 pages and cover. 90 cents. Send stamps or coins to

AMERICAN ACADEMY OF OPTOMETRY

1506-1507 Foshay Tower

Minneapolis 2, Minn.



NOW AVAILABLE TO THE OPTOMETRIC PROFESSION:

THE WOLFE TONOMETER

The use of the Wolfe Scleral Tonometer has been validated for the measurement of increased intra-ocular pressure as in glaucoma.

It may be used for the detection of abnormal diurnal variations, marked differences in comparative pressure of the two eyes and in conjunction with optometrically applied provocative tests, all indicative of incipient glaucoma.

A brochure describing the specific instrumentation and summary of research will be sent upon request.

The Wolfe Tonometer is available in limited quantities, and may be purchased directly.

$42.50

F.O.B. CHICAGO

DEPARTMENT OF CLINICAL RESEARCH

Illinois College of Optometry

Technology Center

3241 SO. MICHIGAN AVE., CHICAGO 16, ILLINOIS

Serving the Nation...

from the Empire State to the Golden Gate

PRESCRIBE *exclusive* GOODSITE BIFOCALS

FEATURING THE 25 M/M FLAT TOP

25 M/M segments for wider close-up vision and efficiency.

WE GIVE COMPLETE SERVICE —There is NO Prescription that We Can't Handle

Our Policy is to Lower Your Costs.

It's simple arithmetic—big new plant plus (+) modern equipment and skilled technicians equals (=) the finest laboratory quality available on a volume production basis. The result is lower costs to your patients and faster service for you.

Interested in the Latest Fashions in Eyewear?

Join our monthly sampling program. You will automatically receive samples of the newest fashions in eyewear for your inspection. Keep only what you want, and return the balance for credit.

COMMERCIAL OPTICAL CO.
Wholesale Optical Supplies
OMAHA, NEBRASKA

The Leading Independent Rx Laboratory in the United States

USE COUPON

COMMERCIAL OPTICAL CO.
BOX 1215, OMAHA, NEBR.

Please send me:

- ☐ Add My Name to Your Automatic Sampling Program
- ☐ Complete Wholesale Price Catalog
- ☐ Rx Mailing Supplies

NAME_____

ADDRESS_____

CITY_____ STATE_____

... TO THE WIDE WORLD, DAL-TEX EXTENDS

Season's Greetings

DAL-TEX
Optical

DALLAS, TEXAS